INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

YGL BULLETIN NO. 6

RIL 1973

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

IFYGL BULLETIN NO. 6

APRIL 1973

UNITED STATES

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DEPARTMENT OF INTERIOR

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ONTARIO MINISTRY OF THE ENVIRONMENT

ONTARIO MINISTRY OF NATURAL RESOURCES

Published by the National Oceanic and Atmospheric Administration,
U.S. Department of Commerce, Rockville, Md. 20852

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Editor	John Sandilands
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NOTE FROM CANADIAN CO-CHAIRMAN

It was with real regret that the IFYGL Steering Committee and the IFYGL Joint Management Team learned, late in 1972, of the imminent departure of Canadian Coordinator Joseph MacDowall to take up a new position in Ottawa.

As most of those associated with the Field Year are aware, Joe MacDowall played a leading role in Canadian participation in IFYGL. In addition to his direct responsibilities to the Steering Committee and Management Team he headed the Canadian IFYGL Centre at the Canada Centre for Inland Waters, Burlington, and was Editor of the official Canadian IFYGL Publications including the Canadian Section of this Bulletin. To quote J. P. Bruce from the Foreword of Bulletin No. 2, Joe MacDowall was the man "who has worked so diligently to pull the scientific and administrative threads together into the whole cloth of the Canadian contribution to the program".

A copy of a letter of appreciation from the IFYGL Steering Committee and the IFYGL Joint Management Team is carried on the following page. We all wish Joe MacDowall well in his new position as Chief of Applications, Canada Centre for Remote Sensing, Ottawa.

With Joe's departure John R. Sandilands, my Administrative Assistant within the Atmospheric Environment Service, has assumed most of the Coordinator's responsibilities while Mrs. Alix O'Hara and Mrs. Barbara Farnworth continue to "man" the Canadian IFYGL Centre at CCIW with an occasional personal assist as required. Their cooperation in taking up the slack created by the change is much appreciated.

T. L. Richards
Canadian Co-chairman
IFYGL Steering Committee
and Joint Management Team

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

AES File: 5964-31-3 (ACHC)

ATMOSPHERIC ENVIRONMENT SERVICE
4905 Dufferin Street
DOWNSVIEW, Ontario M3H 5T4
January 4, 1973

Mr. J. MacDowall
Canadian Co-ordinator
IFYGL Centre
Canada Centre for Inland Waters
P.O. Box 5050
BURLINGTON, Ontario

Dear Joe:

The Steering Committee and Joint Management Team of the International Field Year for the Great Lakes has asked us to transmit to you, upon your imminent departure from the IFYGL scene, their sincere appreciation of your efforts on behalf of the Field Year and to wish you well in your new position.

The position of full time Canadian Co-ordinator was a big one, - one that required skills over a wide spectrum of scientific administration that ran from a first hand knowledge of detailed plans of individual projects to a broad overview of a large international and multi-disciplinary scientific program. That you filled the position well is common knowledge, and we wish you to know that we are sincerely grateful for all your services to the Field Year over the past several years.

Although we will certainly miss your presence we are most pleased that you are moving into a position that will employ your talents to maximum advantage and again wish you well in your new undertaking.

Yours sincerely,

W.J. Drescher
U.S. Co-chairman
IFYGL Steering Committee

E.J. Aubert
U.S. Co-chairman
IFYGL Joint Management Team

T.L. Richards
Canadian Co-chairman
IFYGL Steering Committee and Joint Management Team

c.c. Members of IFYGL Steering Committee and Joint Management Team

LAKE ONTARIO ZOOPLANKTON STUDIES

(IFYGL PROJECT 82BC)

Purpose

The purpose of this study is to correlate the diurnal distribution of crustacean zooplankton with their excretion of nitrogen and phosphorous compounds, and to obtain an estimate of the importance of the zooplankton in the recycling of these nutrients in Lake Ontario.

General Description

Primary production in the aquatic environment is dependant upon the continual supply of inorganic nutrients, the most important of these being nitrogen and phosphorous. In most simplified descriptions of the aquatic cycles of nitrogen and phosphorous it is assumed that these nutrients are made available to the phytoplankton only after bacterial degradation. In this process organic matter in the form of dead plants and animals, exuviae, faeces etc. sinks, is decomposed by benthic bacteria to inorganic nutrients which are then returned to the euphotic zone by vertical mixing of the water column.

However, a much more rapid recycling of nitrogen and phosphorous from organic particles, mainly in the form of PO_4 and NH_3 can occur as the result of grazing and excretion by the zooplankton. The excretion of soluble nitrogen and phosphorous is continuous throughout the year, but assumes a major significance for the primary producers during the period of vertical stratification when no mechanical recycling of plant nutrients to the epilimnion by water mixing occurs. At this time some 80% of the nutrient requirements of phytoplankton within the euphotic zone may be contributed by the excretion of zooplankton.

Some of the zooplankton organisms such as Daphnia retrocurva, remain mostly in the euphotic zone (Figure 1), and thus provide a continuous, but probably variable supply of excreted nutrients for phytoplankton assimilation. Other zooplankters such as Cyclops bicuspidatus thomasi (Figure 2) and Limnocalanus macrurus (Figure 3) undergo diurnal vertical migrations of varying durations and extents, and may only contribute nutrients by excretion to the euphotic zone during a part of the day.

This study is therefore attempting to document the role of zooplankton in the cycling of soluble and particulate nitrogen and phosphorous compounds within Lake Ontario, as well as attempting to calculate the effect of zooplankton grazing and excretion on primary production during the period of vertical temperature stratification.

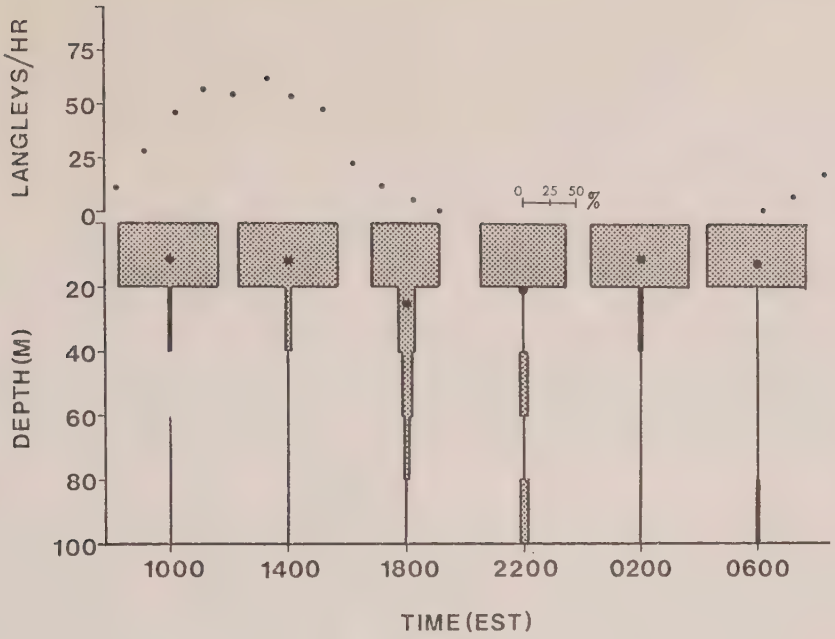

Figure 1. Showing diurnal vertical distribution and relatively limited extent of vertical migration of Daphnia retrocurva on 8→ 9 September 1972, as a percentage of the total population. Large dots represent weighted mean depth of the population. Light intensity during the period is shown in Langleys/hr.

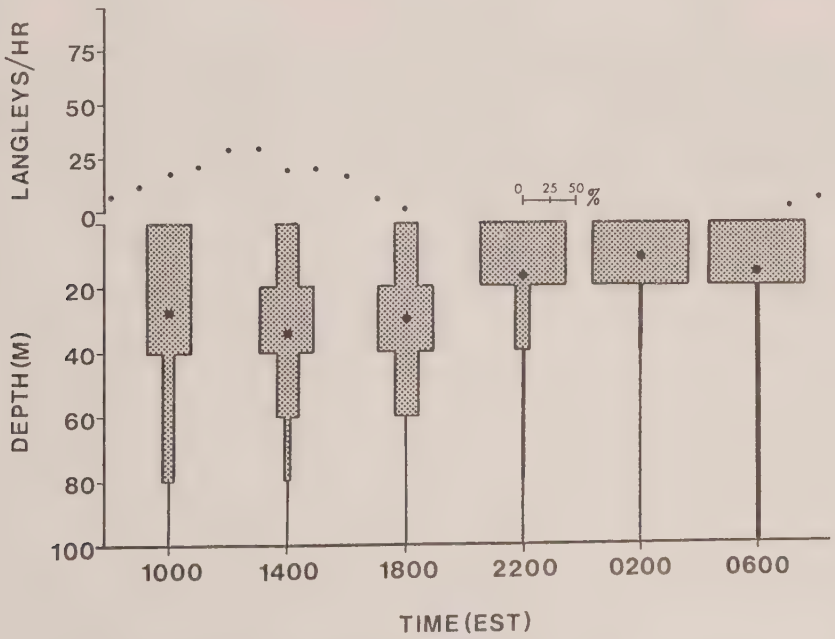

Figure 2. Showing diurnal vertical distribution and migration of Cyclops biscuspidatus thomasi adults on 12→ 13 October 1972, as a percentage of total population. Large dots represent weighted mean depth of the population. Light intensity during the period is shown in Langleys/hr.

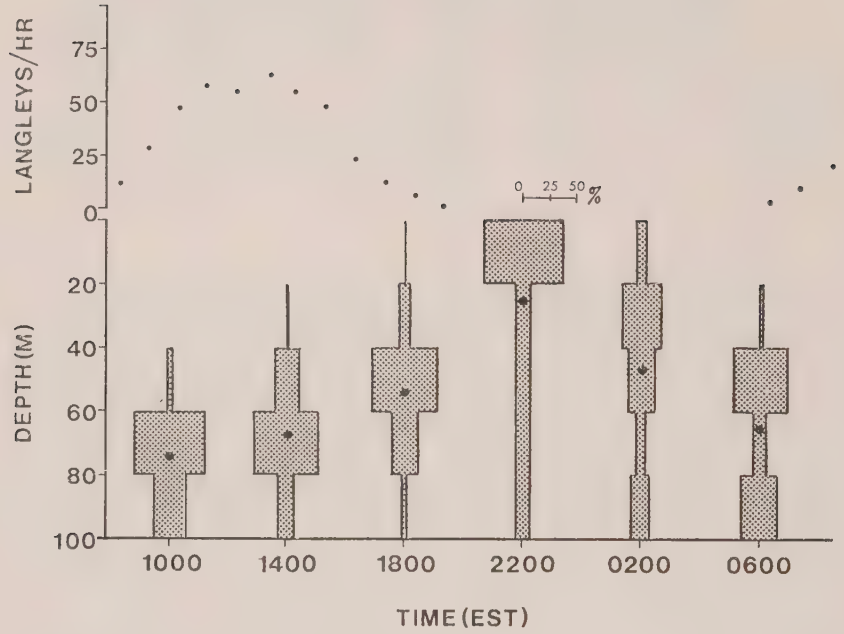

Figure 3. Showing diurnal vertical distribution and migration of Limnocalanus macrurus adults on 8→ 9 September 1972, as a percentage of the total population. Large dots represent weighted mean depths of the population. Light intensity during the period is shown in Langleys/hr.

Studies to date

Sampling to document vertical distribution, migration, and abundance of zooplankton has been conducted at three stations in Lake Ontario. The first, samples on nine occasions from April 1971 to March 1972, is seven miles south-east of Toronto in 100m of water in an area characterised by some upwelling (this is not a scheduled OOPS station). The second and third are stations 11 and 19 of the OOPS Phase II cruise plan in approximately 60m and 180m of water respectively; these two stations have also been sampled on nine occasions each from April 1972 to March 1973.

Sampling was conducted with a closing net of 50 cm mouth diameter and 64 μ mesh. A complete vertical series of collections was collected every four hours during a 24 hr. period, the net being hauled through 10m intervals for each collection at OOPS station 11, and through 20m intervals at the other two stations.

Collections are sub-sampled for identification and counting; a minimum of 20 animals of any one identification group in a maximum of one half of any collection are counted. The average total number of animals counted per sample being about 400-800 depending on the depth at which the sample was taken. Identification groups include:

	Rotifera	- (when present in large numbers)
	Cladocera	- to species
	Cyclopoids	- to adults or copepodites of species
	Diaptomids	- to adults or copepodites of species
Other	Calanoids	- to adults or copepodites of species
	Nauplii	- three size ranges
	Mysis relicta	- three size ranges
	Limnocalanus macrurus	- 6 copepodite stages

Net efficiency has been calculated in an experimental pool as approximately 85% at a towing speed of 0.9 m/s. Parallel series of field collections with nets of different mesh sizes have been carried out to estimate net avoidance by larger organisms and net clogging.

A series of shorter range net hauls to examine the extent of vertical migration across the thermocline by *Mysis relicta* and *Limnocalanus macrurus* (the two most extensive migrators) have also been conducted at OOPS station 19.

Collections from the first station are now completely analysed and those from the remaining two stations are currently being processed.

On each of the OOPS Phase II cruises from April 1972 through March 1973 experiments were carried out on board the MV Martin Karlsen at station 19, in order to measure excretory rates and excretory products of natural mixed zooplankton communities. These closed-system experiments were designed to differentiate between day and night plankton distributions and to distinguish between epilimnetic and hypolimnetic populations.

Chemical analyses for NH_3, NO_2^-, + NO_3^-, total N, reactive P and total P, among others, were run on board ship by the Water Quality Divisions of CCIW using several Auto Analyzer Systems. Results of these experiments are now being co-ordinated to obtain weight and volume specific excretion rates of nutrients by the zooplankton.

Future Work

In addition to the continuing enumeration of zooplankton samples from OOPS Phase II stations 11 and 19, further laboratory experiments on zooplankton excretion will be carried out in 1973 and 1974. Three zooplankton species, Mysis relicta, Limnocalanus macrurus, and Cyclops bicuspidatus thomasi will be studied to investigate more precisely the effects of body weight, temperature, food density etc. on the rate of nitrogen and phosphorus excretion.

Interdigitation

This project has correlations with a number of other IFYGL projects currently under way including the following:

85BC, 86BC, 98BC, 101BC, 80EB, 114WM, 102BC
99BC, 100BC

Synthesis

From data on zooplankton species composition, population density and dry weights the zooplankton community biomass can be calculated in time and space. From the excretion experiments regeneration of nitrogen and phosphorous compounds can be calculated with respect to effects of biomass, temperature etc.

The rates of primary production were concurrently measured at station 19 by means of the C^{14} technique and particulate nitrogen and phosphorous measurements were also taken. From this data approximate uptake rates of N and P by the primary producers can be calculated on a $/m^2$ or $/m^3$ basis. Since the excretion rates of N and P compounds by the zooplankton $/m^2$ or $/m^3$ can also be calculated it should be possible to assess the role of zooplankton in nutrient regeneration in time and space, for:

(a) populations remaining within the euphotic zone;

(b) migrant populations;

(c) individual species.

Much of the file data necessary for these calculations is now available or is being assembled, and it is hoped to make initial calculations of nitrogen and phosphorous fluxes through the zooplankton shortly.

J. C. Roff/J. B. Wilson

PHYTOPLANKTON BIOMASS AND ITS SPECIES COMPOSITION (PART OF PROJECTS 98BC, 101 and 102)

This project is a continuation of a planned long term study of Lake Ontario phytoplankton, started during 1969 with the purpose of collecting and documenting information on the composition and abundance of phytoplankton on a lakewide and year round basis. Such information was lacking in the past. The results of the 1969-70 study yielded considerable new and interesting data about thelake's phytoplankton. These data have been published (Munawar & Nauwerck, 1971). Plankton material has also been preserved and permanent preparations were made for record as no such baseline material was available for comparison and reference in 1969.

The objectives of the present study are many fold and are described below:

(a) to substantiate and follow up the taxonomic studies made during 1969-1971;

(b) to make further additions to plankton collections and permanent preparations as part of an ongoing practice to document, preserve and catalogue plankton of the Great Lakes. This could be used for reference and comparison amongst various investigators;

(c) to study the horizontal and vertical distribution of total phytoplankton biomass and species composition with particular emphasis on phytoflagellates. Also to study the phytoplankton changes more frequently at two master stations in order to compute generation time of common species. A comparison of volumetric data with that of ATP as a measure of biomass is also planned;

(d) to evaluate the relationship between phytoplankton distribution and certain physico-chemical factors such as temperature, phosphorus, nitrogen and silica.

Integrated water samples (0 - 10 meters) are collected at 3 week intervals during the OOPS Cruises (Phase I) throughout the year on 14 selected stations distributed over the entire lake. Samples are mixed thoroughly; a portion is preserved in Lugol's solution and another portion kept alive (unpreserved) in a pool at lake temperature. The live samples are analyzed immediately at the completion of the cruise to facilitate taxonomic identification, particularly that of flagellates. The preserved samples are enumerated later by an inverted microscope (Utermöhl, 1931) which provides detailed information on species composition and the total biomass. Two master stations have been selected where an intensive study of phytoplankton abundance is being carried out. The

master stations are Stations No. 11 and 19 where the samples are collected every 6 hours during Phase II. Vertical profiles are made during Phase I at 10 stations distributed in various parts of the lake, and Stations 11 and 19 during Phase II. The samples are collected by Van Dorn bottle at the following depths and preserved in Lugol: 1, 5, 10, 15, 20, 40, 80, 160 and 2 meters from the bottom.

Samples have been collected as per the project plans except for a few vertical profiles which were not collected due to various reasons. Live samples were found to be very helpful in identification of the flagellates. All the live samples were analyzed regularly after each cruise so that up-to-date data are available on the special composition of total phytoplankton. The enumeration of preserved samples is in progress.

M. Munawar and I.F. Munawar

WIND AND TEMPERATURE FLUCTUATIONS
(IFYGL PROJECT 75 BL)

Progress Report, January 1973

This project forms part of the eddy-flux measurement program of the BIO Air-Sea Interaction Group.

The first of three field trips was to Niagara-on-the-Lake from September 17 to October 15, 1971. The purpose of this trip was to obtain wind stress and heat flux from a proven turbulence sensing, recording and analysis system to serve as a reference in the trial and evaluation of similar systems by local IFYGL participants (CCIW - Project 5 BL and AES - Project 28 BL). An additional goal was to compare the performance of a modified thrust anemometer for wind turbulence measurements with our well-accepted sonic anemometer. Some 19 data runs of 40 minutes' average duration were obtained, plus one longer run of 80 minutes' duration. Humidity and evaporation were measured for two runs with a sensor kindly loaned by the CCIW group. No attempt was made to obtain continuous records of turbulence through the observation period since the computer time to analyse larger quantities of data would be prohibitive. The measured wind stress and heat flux were represented in terms of mean wind speed, air temperature and water temperature which would allow their calculation from meteorological buoy data, and the results were presented at the 3rd National Oceanographic Symposium, CCIW, May 1972.

The thrust anemometer tests revealed an unacceptable amount of drift which turned out to be caused by a greenhouse effect in a translucent fiberglass cover, causing the anemometer to warm up by some 10 to 15 ^{o}C on sunny days, and to cool down when the cover was opened. Useful results were obtained only on days with heavy overcast.

The second trip, June 11 to 24, 1972 was again to Niagara-on-the-Lake with similar system. We once again made use of the barge Handy Boy and masts at Niagara Bar set up by CCIW. The cover of the thrust anemometer had been given a shiny metallic finish, reducing greenhouse-effect drift by a factor of 20 or better, and we had added a Lyman-Alpha humidiometer to our sensor package. Eleven useful data runs were obtained during the period. Data sheets for the 1971 and June 1972 experiments are available from the Canadian IFYGL Data Centre and spectra and cospectra from individual runs can be supplied by the authors on demand. Preliminary indications are that the thrust anemometer can now produce acceptable data.

A third experiment was carried out from October 1 to 13, 1972. A sonic anemometer and micro-thermistor were mounted on Bedford Buoy #1 off Port Credit, Ontario. These were remotely controlled and data were telemetered by a radio link to the CCIW building for recording; the purpose of the experiment was to demonstrate feasibility of the telemetering system. The Bedford Buoy has the advantage over the Niagara Bar site of being farther out in Lake Ontario and values more representative of the Lake as a whole may be obtained.

On the other hand, problems are imposed by inaccessibility of the sensors and by the possibility of motion of the buoy being mixed in with the turbulent velocity signals. One test run has given favourable results and computer analysis of the remaining data is now underway.

S. D. Smith and E. G. Banke

Table 1. Preliminary data, Project 75BL, June 1972. Location: Niagara Bar, centre mast 43°17'N, 79°07'W Kaijo Denko sonic anemometer and micro-thermistor, height 8.9 m.

Start Min.	Time (GMT) Day/Mo./Yr.	Dur'n Min.	Wind U_{10} m/s	Mean Products $\langle U_1U_3 \rangle$ $(m/s)^2$	$\langle U_1U_2 \rangle$ $(m/s)^2$	$\langle U_2U_3 \rangle$ $(m/s)^2$	$\langle tu_3 \rangle$ $^oCm/s$	$\langle U^2U_3 \rangle$ $(m/s)^3$	Temp. Variance σt σc
2158	16/06/72	44	3.76	-.0096	.0283	0.0029	-.0026	0.0002	.22
1653	17/06/72	44	7.80	-.0847	-.0010	0.0004	-	0.0772	-
1850	17/06/72	44	5.11	-.0377	0.0004	0.0019	0.0033	0.0143	.10
1955	17/06/72	44	3.88	-.0127	-.0049	-.0004	0.0012	0.0612	.10
1637	18/06/72	44	9.24	-.0969	-.0458	0.0133	0.0136	0.0502	.16
1738	18/06/72	44	10.01	-.1101	0.0070	0.0034	0.0117	0.0584	.16
1836	18/06/72	44	9.45	-.1044	-.0308	0.0068	0.0076	0.0068	.12
1937	18/06/72	44	9.21	-.0988	-.0379	0.0065	0.0071	0.0338	.21
2035	18/06/72	40	9.28	-.1051	-.0113	0.0013	0.0076	0.0242	.14
1920	18/06/72	44	4.60	-.0147	-.0048	0.0000	0.0008	0.0028	.09
1921	21/06/72	44	7.50	-.0672	-.0213	0.0029	0.0042	0.0224	.16

Table 1. Preliminary data, Project 75BL, June 1972 (continued)

Start Min.	Time (GMT) Day/Mo./Yr.	Turbulence Levels				Gust Factors				Tilt θ deg.	Drag Coeff. $10^3 C_{10}$	Stability z/L
		σ1/U	σ2/U	σ3/U	σ3/U*	G	g1	g2	g3			
2158	16/06/72	.092	.070	.040	1.55	-	-	-	-	3.2	0.68	0.037
1653	17/06/72	.071	.062	.045	1.18	1.20	.47	.50	.44	3.6	1.39	-
1850	17/06/72	.076	.063	.043	1.11	1.28	.58	.50	.46	4.4	1.45	-.006
1955	17/06/72	.070	.061	.041	1.41	1.21	.48	.53	.38	3.2	0.84	-.012
1637	18/06/72	.081	.057	.047	1.38	1.27	-	.54	.48	3.9	1.14	-.006
1738	18/06/72	.075	.058	.050	1.49	1.31	.61	.57	.46	4.1	1.10	-.004
1836	18/06/72	.074	.058	.049	1.42	1.28	.58	.51	.46	3.9	1.16	-.003
1937	18/06/72	.078	.058	.048	1.39	-	-	-	-	3.6	1.17	-.003
2035	18/06/72	.079	.059	.050	1.41	1.29	.58	.51	-	3.8	1.22	-.003
1920	18/06/72	.064	.057	.037	1.39	1.23	.49	.46	.36	2.7	0.70	0.001
1921	21/06/72	.104	.088	.049	1.41	1.42	.75	.74	.52	3.5	1.19	-.003

METEOROLOGICAL BUOY MEASUREMENTS

(IFYGL PROJECT 44 BL)

The primary portion of the Meteorological Buoy Measurements was terminated in mid-December. An overall average of 91% of possible data was obtained. Data from all stations have been examined and are ready for verification. Verification has been completed for data through mid-August and these data are available to the IFYGL data bank.

One buoy has been left at station mooring number 2 during the winter. A record change was accomplished in mid-February and performance seems normal. Heavy ice accumulation has not affected performance but the humidity sensor does not function properly at below freezing temperatures This mooring will be maintained through the remainder of IFYGL if ice conditions permit.

F.C. Elder

WAVE CLIMATOLOGY OF LAKE ONTARIO BY VISUAL WAVE OBSERVATION

Description

During IFYGL a program of visual wave observations from the major research vessels at the Canada Centre for Inland Waters is initiated to establish the climatological characteristics of wind waves in Lake Ontario.

The data is based on an estimated total number of 15,000 individual visual observations from five major research vessels in Lake Ontario.

A comparison of data collected from wave gauge records is made with visual wave observations and estimates by the Sverdrup, Munk and Bretschneider (SMB) wave hindcasting techniques based on surface lake wind records.

Team Members

H. K. Cho - Principle investigator (responsible for all the data collection and analysis).

F. Elder - Scientific coordinator (technical guidance of the data acquisition systems and analysis).

Work Schedule

Analysis	Data Source	Type of Data	Anticipated Completed Date of Data Collection
% Frequency of waves (regional, Seasonal and directional)	1. M. Karlsen 2. CSS Limnos 3. P. Dauphine 4. Researcher 5. Advance II	Wind, waves, air temps, water temps, locations	April 1973
Comparison of Wave Data	1. 3 Canadian Wave Buoys (from project No. 76 WM)	Waves	May 1973
	2. Canadian Met. Buoys (Buoy No. 2, 3, 7 & 11)	Winds	April 1973

Work Schedule Continued

Analysis	Data Source	Type of Data	Anticipated Completed Date of Data Collection
3.	Commercial Ships (from AES Toronto)	Waves, winds, locations	June 1973
4.	Application of SMB Wave Hind-casting Techniques	Winds, fetch	July 1973

Anticipated Date of Publication

Due to the large volume of data being collected and the time needed for processing of this data, a publication will not be available until approximately December 1973.

H. K. CHO

Ship's Activity

A total of 14 more cruises have been filed with the IFYGL Centre since the issue of Bulletin 5, bringing the total to 90 for the period from April 1, 1972 to the end of February 1973. Due to ice and stormy weather there were many delays in station monitoring as well as several changes in cruise plans and number of stations monitored. For more details see the applicable Cruise Reports available from Technical Operations, Canada Centre for Inland Waters.

Heat Content and Surface Eutrophication Survey

A total of eight surveys were carried out for this program on the following dates: December 5 - 10, December 11 - 15 and December 18 - 20, 1972; January 3 - 6, January 8 - 12, January 15 - 18, January 29 - 31 and February 12 - 15, 1973. Six of the surveys were carried out simultaneously by the CSS Limnos and the CCGS Porte Dauphine. On the January 3 - 6, 1973 cruise the M.V. Martin Karlsen replaced the Limnos and on the February 12 - 15 cruise the Limnos monitored additional stations to the normal quota as the CCGS Porte Dauphine was unable to operate.

Bathymetric Survey

Between November 27 and December 2, an additional 576 nautical miles of bathymetric survey was completed by the CSS Limnos with some interruptions due to heavy seas. In addition to this,meteorological and limnological data were taken and time spent on calibrating Decca buoys.

Ontario Organic Particle Study (OOPS)

The eighth OOPS cruise was made by the Martin Karlsen on January 9 - 12 and 15 - 20, 1973. This was the first OOPS cruise in which not all observations were taken. Eleven stations were missed in Phase I and in Phase II good results were obtained for stations 19 and 3 (substituted for station 11 where measurements were not feasible).

Buoy Maintenance and Service

The ship effort during this period was directed primarily towards retrieval of buoys for the winter period. All operations were carried out successfully although there were some delays and interruptions due to poor weather. More details of the cruises are given in Table 2.

Table 2. Canadian buoy and system service cruises (a continuation of Table 12 in Bulletin 5, p. 49)

System	Dates (1972)	Ship	Task
Decca	November 30 - December 2	L	Decca calibration (Phase IV)
Meteorological	December 3 - 8 + 11	LE	Removal of instruments from meteorological buoys
Meteorological	December 8 - 9	L	Retrieved meteorological moorings 3, 6, 7, 8, 9, 10, 11 and two Waverider Buoys (8 + 11). Two thermographs remoored.
Meteorological	December 11	L	Retrieved remaining meteorological buoys 1, 2, 4, 5(13)

Aircraft

Lake Surface Temperature by ART

This program of overflights has now been completed with the addition of twelve flights between December 11, 1972 and the end of the Field Year, bringing the total to forty-seven for IFYGL. The dates of survey were: January 2, 17, 25 and (30); February 5, 13, and 23; and March (8), 9, 16, 20 and 26, 1973, where parentheses indicate that conditions restricted the flight to the western half of the lake.

Canada Centre for Remote Sensing

A mission summary is given in Table 3. This is a continuation of the information given in Bulletin 5, p. 50 - 51.

Table 3. CCRS remote sensing activity associated with IFYGL

Investigator	CCRS No.	Date	Height (M)	Sensor	Film	Filter	Focal Length (mm)	Format
K.P.B. Thomson	72 14	27/10/72	8230 ASL	C C C	2445 2443 2498	NAV W12	88 3"	9 x 9 70 mm RS145" Scan
K.P.B. Thomson	72 15	29/5/72	1829 AGL	Daedalus Scan				
		27/9/72	1829 AGL	Daedalus Scan				70 mm
		28/9/72	1829 AGL	Daedalus Scan				70 mm
		2/10/72	1829 AGL	Daedalus Scan				70 mm
		4/10/72	1829 AGL	Daedalus Scan				70 mm

The Level of Lake Ontario

The level of the lake has increased over one and a half feet since its lowest point in November 1972. The actual levels recorded at the six Canadian stations are given in Table 4, which is a continuation of data given in Table 14, p. 52, Bulletin 5.

Table 4. The monthly mean elevation 1972-73 of the surface of Lake Ontario above the mean sea level in the St. Lawrence at Father Point, P.Q. (feet)

	November	December	January	February	March
Port Weller	244.63	244.99	245.71	246.30	246.76
Toronto	244.69	245.01	245.76	246.35	246.75
Cobourg	244.68	244.99	245.75	246.34	246.73
Kingston	244.51	244.82	245.68	246.14	246.51
Burlington	244.79	245.15	245.83	246.46	
Pt. Petre	244.67	245.00			

Project List

The following are recent changes to the Project List given in Appendix I, Bulletin 2. Previous changes and additions were given in Bulletin 4 and 5 in the Coordinator's Notes. More information on these Projects together with progress reports provided by the Project Leaders can be found in Canadian Projects and Canadian Projects, Supplements 1, 2 and 3, available from the Canadian IFYGL Centre, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario, L7R 4A6.

14TW, 46TW	B. E. Russell is no longer Project Leader and has been replaced temporarily by E. A. MacDonald until a permanent Project Leader can be assigned.
38TW	Under Project Members delete W. D. Hopkins and add N. D. Warry and K. H. Sheardown.
98BC, 101BC, 102BC	Add I. F. Munawar as co-investigator.
101BC	Replace W. Glooschenko by P. Stadelmann as co-investigator.
105BC	Withdrawn

Lake Ontario Basin Weather Data

This information is a continuation of that given in Bulletin 5, p. 56 and has also been taken from the leaflet "IFYGL Weather Data" published by Atmospheric Environment Service.

The weather of July 1972 was near normal. A cool period at the beginning and the end of the month combined with a heat wave during the middle of the month to produce normal average monthly mean temperatures. Except for the west and northwest sections rainfall was near normal. (Buffalo recorded the lowest rainfall in 39 years.) In most of the Basin lighter than usual winds were recorded.

In August the cool, wet weather returned. Mean maximum temperatures averaged 0-4^{o}F below normal and precipitation was above normal everywhere. In some places it was over twice the monthly normal. Mean wind speeds remained low at most stations with Toronto Island Airport recording its lowest mean wind speed for the month at 6.2 mph.

RECENT PAPERS AND REPORTS OF INTEREST TO IFYGL PARTICIPANTS

Haefeli, C. J. 1972. Groundwater Inflow to Lake Ontario from the Canadian side. Scientific Series No. 9, Inland Waters Branch, Department of the Environment, Ottawa (IFYGL Project 13 TW).

Ongley, E. D. 1973. Sediment Discharge from Canadian Basins into Lake Ontario. Department of Geography, Queen's University, Kingston. To be published.

Phillips, D. W. 1972. Modification of Surface Air over Lake Ontario in Winter. Monthly Weather Review, Vol. 100, No. 9, p. 662.

UNITED STATES

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and typing

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COMMENTS BY THE U.S. DIRECTOR

This issue covers primarily activities during the third quarter of the Field Year, October 1 to December 31, 1972 (see fig. 1), but some reports on events in January and February 1973 are included.

IFYGL data collection reached a peak in October, with all major acquisition systems in operation. By the end of November, all the U.S. buoys and towers were shut down and retrieved from the lake. The land stations continue routine operation. The *Researcher*, *Advance II*, and *Johnson* departed on December 2, the other ships on various dates between October 26 and December 14. The rawinsonde network functioned very well during this quarter although not without some problems, e.g., inadequate supply of expendables. The weather radar, precipitation, and snow measurement networks are all operating satisfactorily. Data collection during the quarter was 80 to 90 percent of that planned.

The staff at the U.S. Field Headquarters for IFYGL in Rochester was sharply reduced in December after the ship, buoy, tower, and rawinsonde operations had been terminated. A small support group is to remain through March, when the rest of the data acquisition systems will close down.

IFYGL data management activities are now combined at the Center for Experiment Design and Data Analysis (CEDDA), Page Building 2, EDS, NOAA, Washington, D.C. 20235. Intensive efforts are underway to complete the needed software and begin processing of the ship, rawinsonde, and TI data. The number of data requests received by the U.S. IFYGL Data Manager, Dave Drury, are increasing. Data requests from U.S. IFYGL participants will be filled to the extent feasible and as required for carrying out analyses as specified in the IFYGL Technical Plan. Service charges will be imposed to cover retrieval costs for other data requested that do not meet the criteria established by the Technical Plan.

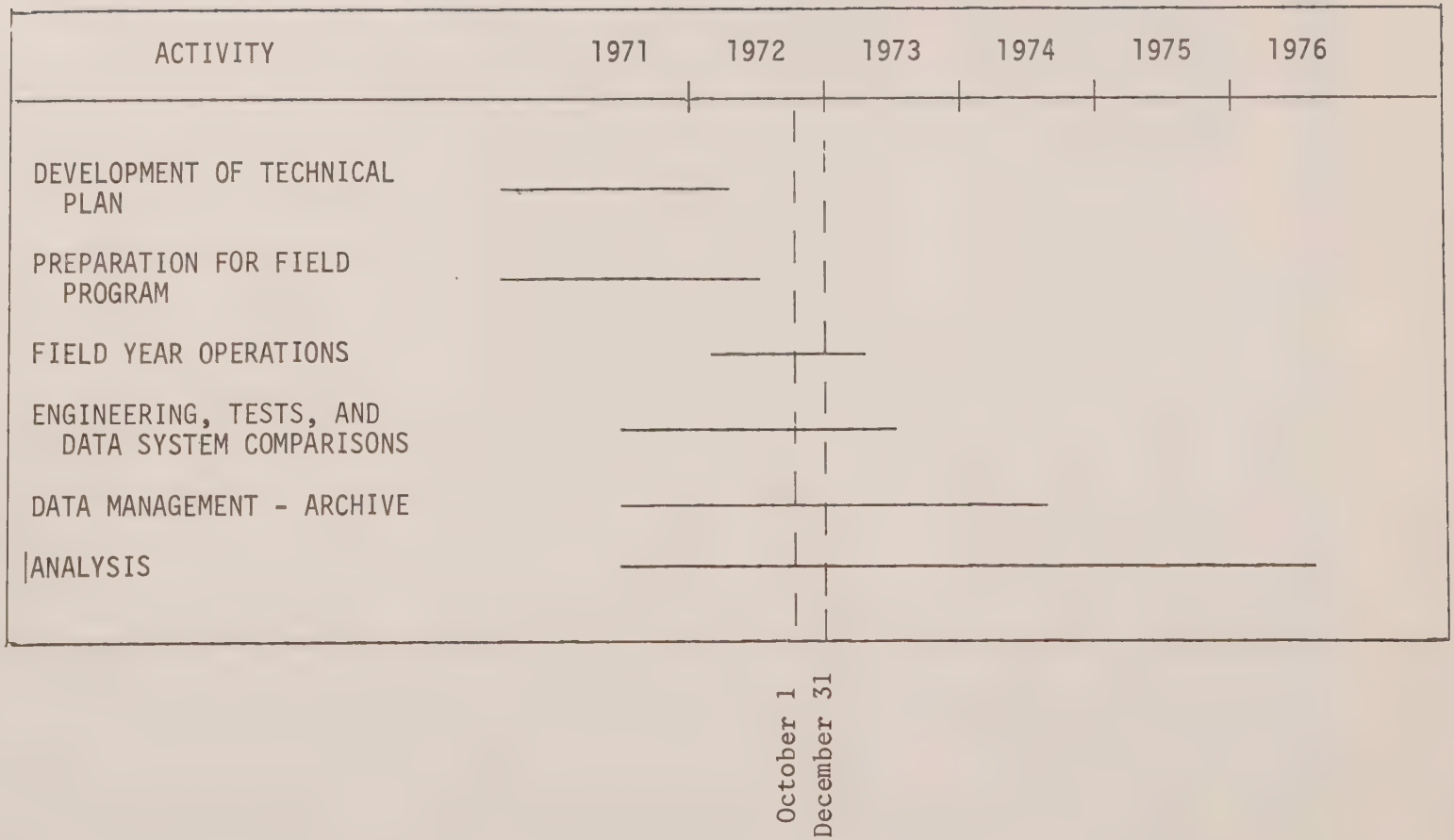

Figure 1. U.S. IFYGL schedule.

U.S. SCIENTIFIC PROGRAM

Based upon reports requested by the U.S. IFYGL Project Office, the progress from October 1 through December 31, 1972, is presented for each of the U.S. IFYGL tasks. Some reports cover work done in January and February 1973.

A new task, "Snow Observation Network," has been added in support of Task 69, "Basin Precipitation - Land and Lake." The latter, in turn, supports the Terrestrial Water Balance and Atmospheric Water Balance Projects.

Following the task reports, a summary is given of the status of work in terms of the broad project areas.

Tasks

1. *Phosphorus Release and Uptake by Lake Ontario Sediments*

Principal Investigators: D.E. Armstrong and R.F. Harris - University of Wisconsin

No report.

2. *Net Radiation*

Principal Investigator: M.A. Atwater - CEM

The surface and radiosonde meteorological data for the Lake Ontario basin for June through September have been put on magnetic tape. Data for October to December are being processed.

A cloud analysis is required before computation of the radiation balance for Lake Ontario. Such an analysis can easily be made when ship reports are available, but these reports are irregular and cover limited periods of time. To improve the analysis, a statistical model is being developed, based on readily available land data. Means and standard deviations for each of the parameters contained on the magnetic tape can be computed, and a linear regression technique is being used to develop the cloud analysis model.

A study was made to determine an appropriate time step for the radiation computations. The input data are specified at not less than every hour and generally at longer intervals. For shorter time steps, linearly interpolated data will be used. A 2-week period in September was chosen for studying the effect of various time steps on the net

radiation balance. A cloud analysis based on surface data and on an earlier model of lake effects on clouds was used to obtain representative clouds. As shown in the table below, it was found that a time step of 1 hour is near the optimum when the radiation balance is computed for 1 week or longer. For periods of less than 1 day, 0.2 hours should be used.

Maximum difference, in percent, between a time step of 0.2 hours and other time steps used in computing the net radiation balance

Time step (hour)	Computer cost ($)	2 weeks	1 week	1 day	6 hours
0.2	12.47	-	-	-	-
0.5	7.82	0.02	0.07	0.50	1.50
1.0	5.80	0.03	0.10	1.00	3.00
2.0	4.97	0.70	1.00	3.00	25.00
3.0	4.44	1.20	3.00	5.00	100.00

The mean lake temperature has been computed from the lake surface temperatures reported for the IFYGL stations during ship cruises. Initial results were included as an appendix to the last quarterly report. Data through November have now been received. Temperature data from the Canadian aircraft flights have also been received. The results based on both sets of data are shown in figure 2, which indicates good agreement, particularly in view of the different time scales involved. The mean lake temperature is used to compute the emitted infrared radiative component and is a factor in the downward atmospheric radiation at the surface.

A report has been written describing the specification for the computer program, the data input, and the type of data output that is possible. Reports indicated in the IFYGL Technical Plan, Volume 1, should be ready by April 1, 1973.

3. *RFF/DC-6 Boundary Layer Fluxes*

Principal Investigator: B.R. Bean - ERL/NOAA

During the five alert periods the following hours were flown during the days indicated in support of the airborne measurement program:

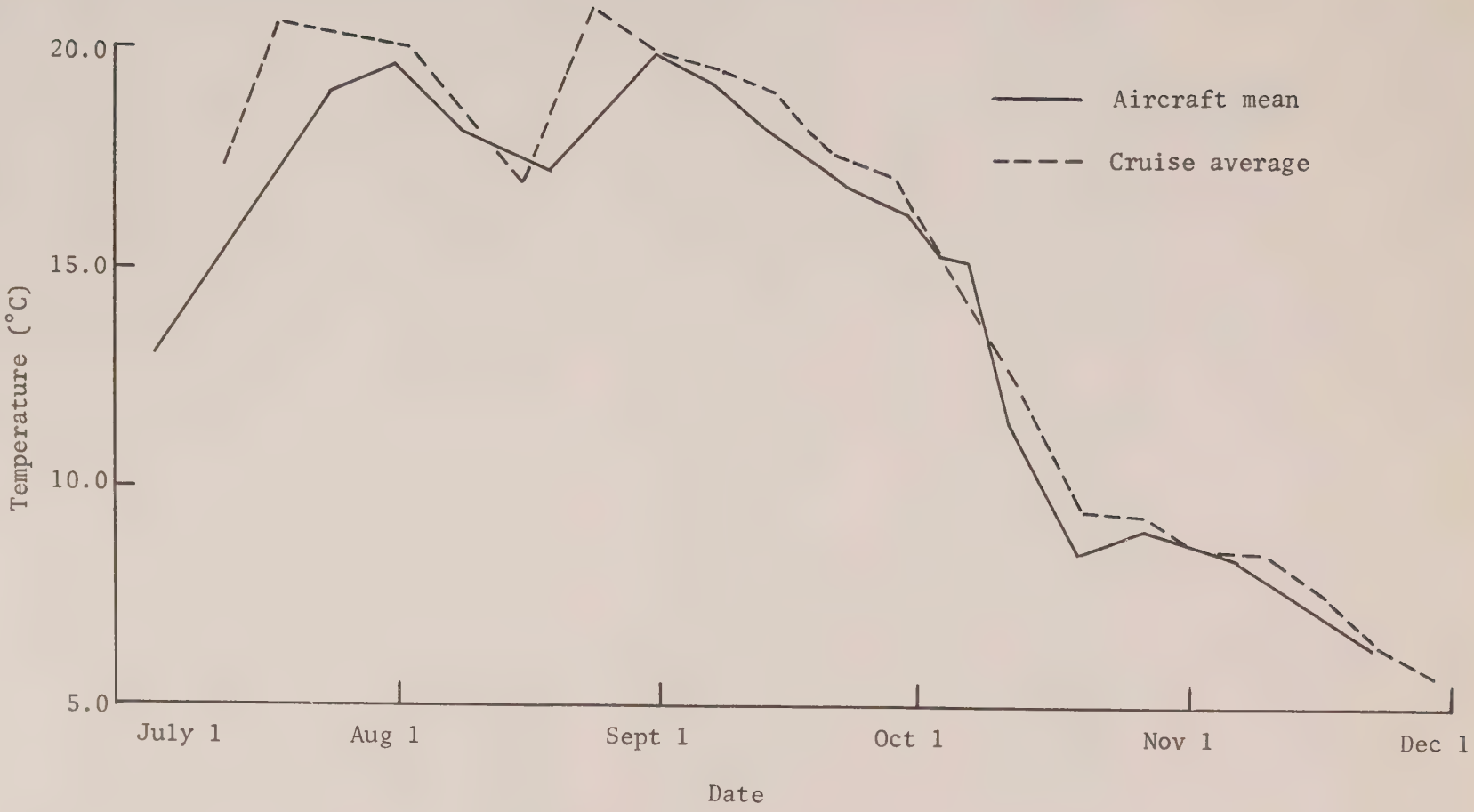

Figure 2. Mean lake temperature from the United States ship cruises and the Canadian aircraft flights.

	Number of days	Flux program	Support of other programs
May	9	34	7.5
June	8	19	17
August	4	19	0
October	6	22	4
November	4	14	0
	31	108	28.5

During the early periods, when the water was cooler than the air, temperature inversions were strong and close to the surface. Fluxes were negative or near zero. As the lake warmed, inversions became weak and the fluxes turned positive. Water vapor flux decreased as a function of height but increased as a function of fetch. Significant fluxes at 1,000 ft were not measured until October. The representative parameters measured at 100 ft are shown in figure 3.

The days considered in this gross analysis are as follows:

May 11-13

The surface temperature of the lake was on the average 2°C, increasing slightly on the downwind side; hence the air temperature was considerably warmer. Strong temperature inversions were common, from as low as 100 ft on the upwind side to more than 1,000 ft on the downwind side. Fluxes were predominately zero or negative over the lake, positive over the ground. There was little suggestion of a change of flux with fetch.

June 19-20

The surface temperature of the lake was 12° to 15°C near the shores, but only 5° to 10° at the center; the air, however, was still considerably warmer. Strong temperature inversions occurred below 100 ft on the upwind side to above 1,000 ft on the downwind side. The average air temperature decreased downwind; fluxes were essentially zero except at the center, where, because of the much colder water, the fluxes were negative.

August 15-16

The wind was primarily light and variable. The surface temperature of the lake was about 20°C, not much different from the air temperature. The surface temperature increased slightly downwind. Inversions were weak and not perceptible on the downwind shore. Above 1,000 ft the fluxes were near zero. At 500 ft and below the water vapor flux ($f_{\rho w}$) was positive and increased slightly as a function of fetch. At 60 ft the water vapor flux on the upwind shore was equivalent to 0.1 cm/day on the downwind shore 0.25 cm/day. The heat flux (f_T) was zero on the downwind shore and slightly negative upwind.

May 11

	N	C	S
$\overline{\rho_w}$	5.7	6.0	6.4
$\overline{\rho_w'W'}$	0.07	-0.05	0.0
$\overline{T'W'}$	-4.80	-1.20	-4.00
T_o	2.4	1.8	1.8

June 20

N	C	S
		15.4
		0.0
		1.08
15.0	6.0	14.0

Aug. 15

N	C	S
10.0	12.0	11.9
0.40	0.20	0.32
-3.62	-1.93	0.0
19.2	19.8	20.5

Oct. 9

	N	C	S
$\overline{\rho_w}$	4.1	4.4	5.3
$\overline{\rho_w'W'}$	0.50	0.98	1.34
$\overline{T'W'}$	1.33	12.2	14.9
T_o	7.7	12.0	15.2

Nov. 21

N	C	S
2.5	2.7	2.7
0.26	0.30	0.24
8.20	8.70	7.70
6.8	4.5	6.3

Winds

May	W
June	SW
Aug.	E
Oct.	NW
Nov.	N

Figure 3. Parameters measured at 100 ft by RFF DC-6 39C aircraft. N = North; C = Center; S = South; $\overline{\rho_w}$ = gm/m^3; $\overline{\rho_w'W'}$ = cm/day; $\overline{T'W'}$ = mw/cm^2; T_o = °C.

October 9-10

The 9th was a good day, wind NW, 25 knots. The surface temperature was about 14°C; the air temperature at 100 ft was about 6°C. No inversions were found. The water vapor flux was positive and decreased with altitude and increased with fetch. Although on October 10 the wind changed to southerly, it was light, and the influence of the previous day was still noted. The heat flux showed an increase with fetch, particularly at 500 ft and below. The unusually low values of the fluxes measured at the north shore on October 9 (and to a lesser degree on the 10th) are attributable to a sharp boundary in the surface temperature of the lake. A strong north wind of 25 knots apparently was blowing the warm surface water downwind causing an upwelling of much cooler water. North of the boundary the surface temperature (T_o) was 6°C; south of the boundary it was 11.5°C. A sharp interface of 2°was noted across a visible white streak on the surface (foam?). Both the air temperature and the water surface temperature increased downwind.

November 19 and 21

The surface temperature was between 3°C and 6°C. The temperature of the air at 100 ft was +3° → -3°. No inversions; f_T decreased as a function of height and appeared constant with fetch. At 500 ft and below $f_{\rho w}$ was relatively constant ($\sim$0.2 cm/day) with fetch; at 1,000 ft there was an increase to the downwind side. The surface temperature was slightly cooler in the center (also $f_{\rho w}$ was a bit smaller at the center). The average water vapor flux at 100 ft was 0.2 → 0.3 cm/day.

4. *Nitrogen Fixation*

Principal Investigator: R. Burris - University of Wisconsin

No report.

5. *Profile Mast and Tower Program*

Principal Investigator: J.A. Businger - University of Washington

Two stations were set up on the lake - one near the north shore in Cobourg harbour, and the other near Rochester. Mean profiles of wind, temperature, and humidity were measured at both stations by instruments on roving probes as well as on fixed locations on the mast or tower. Measurements of turbulent intensities and fluxes (by eddy correlation) were made primarily on the Rochester tower. Despite the initial delay in our data collection, we obtained more than 100 hours of good data between October 7 and 15.

Recalibration of the sensors in the wind tunnel, and planning and programming for data reduction proceeded after the field experiment as planned.

6. *Status of Lake Ontario Fish Populations*

Principal Investigator: J.F. Carr - Great Lakes Fisheries Laboratory

The fifth and final survey (Cruise X) of offshore fish stocks in Lake Ontario was completed by the *Kaho* in October. A report describing areas of operation and sampling results has been distributed to IFYGL participants.

Computer summaries of all catch data collected during the offshore fish stock assessment work have been completed. These, as well as echo sounder records collected by the *Researcher*, *Advance II*, and *Kaho*, are being analyzed.

A preliminary report of the U.S. offshore study is tentatively scheduled for completion in June 1973.

7. *Material Balance of Lake Ontario*

Principal Investigator: D.J. Casey - EPA

No report.

8. *Runoff*

Principal Investigator: L.T. Schutze - U.S. Army Corps of Engineers

First-cut estimates of monthly runoff from the U.S. land area have been made for the months of July through November 1972. Analysis of runoff data has still not begun because the water balance data are incomplete. Data on runoff from the basin in Canada has been estimated for April through November.

9. *Evaporation (Lake - Land)*

Principal Investigator: L.T. Schutze - U.S. Army Corps of Engineers

A first-cut estimate of May-July monthly evaporation was prepared and sent to IFYGL Panel Chairmen, Steering Committee Members, and Program Coordinators. Provisional monthly data through November were compiled for inflow, outflow, storage on lake, precipitation, and groundwater.

10. *Simulation Studies and Analyses Associated With the Terrestrial Water Balance*

Principal Investigator: B.G. DeCooke - U.S. Army Corps of Engineers

Activity has not begun.

11. *Land Precipitation Data Analysis*

Principal Investigators: L.T. Schutze and R. Wilshaw - U.S. Army Corps of Engineers

Investigation has not started.

12. *Transport Processes Within the Rochester Embayment of Lake Ontario*

Principal Investigator: W.H. Diment - University of Rochester

No report.

13. *Soil Moisture and Snow Hydrology*

Principal Investigator: W.N. Embree - U.S. Geological Survey

Soil-moisture data collection continued on a monthly basis at the 11 active sites in the Black River basin. Analysis has begun to establish a basinwide value of soil-moisture change.

14. *Boundary Layer Structure and Mesoscale Circulation*

Principal Investigator: M.A. Estoque - University of Miami

The observational program was carried out successfully from October 1 to 14. A pronounced air-mass modification phenomenon was observed. Progress is being made in formulating theoretical models.

15. *Mesoscale Simulation Studies*

Principal Investigator: M.A. Estoque - University of Miami

No report.

16. *Lake Level Transfer Across Large Lake*

Principal Investigator: C.B. Feldscher - LSC/NOAA

Water level data were acquired, and special gages were removed. No progress was made in studies of the data.

17. *Nearshore Ice Formation, Growth, and Decay*

Principal Investigator: A. Pavlak - General Electric Company

The lake shore ice experiment being conducted during the 1972-73 winter is designed to measure parameters required to characterize the thermal energy balance in a vertical plane oriented perpendicular to the shoreline. The essential elements of the experiment are three offshore thermistor strings, two of them terminated by vertical risers, two soil probes, a meteorological package, and an instrumentation van.

Deployment of the offshore thermistor strings and ground probes was completed on November 3, 1972. Deployment of the instrumentation van and meteorological package was completed on November 30, and data acquisition was begun on December 1. Data tapes and time-lapse films are being sent to GE at Valley Forge on a weekly basis. Computer programs have been developed, data reduction is proceeding, and biweekly data reports will be issued shortly.

Severe surface waves and breakers were encountered during several storms in December. The time-lapse photographs indicate that during one storm waves breaking against shore ice were spraying 18 ft into the air. Such severe surf was not anticipated when the experiment was designed, and, as a result, the underwater sensors have suffered some damage. Specifically, six of the eight thermocouple pairs have been torn from the cable; the two deepwater thermocouples are still surviving. Four of the 15 thermistors have been damaged to the point where it may be difficult to obtain useful data from them.

Some redundancy has been designed into the experiment, and it is believed that the damage to date does not compromise the goals and objectives of the program. For example, ΔT near the bottom, which was to be measured by the thermocouple pairs, can be inferred from the vertical temperature profiles sensed by the two vertical risers.

18. *Advection Term - Energy Balance*

Principal Investigator: J. Grumblatt - LSC/NOAA

Preliminary results from reduction of field data indicate strong thermal stratification at North and South Wolfe Island cross sections and almost complete vertical mixing in the Clayton, N.Y., - Gananoque, Ontario, area. A digital water temperature recorder was installed at Bartlett Pointe, Clayton, on December 14, 1972. Preliminary heat-flow tabulations for the lower Niagara River have been completed for the period mid-May through December 1972.

Operation of water temperature recorders will continue at Lewiston, N.Y., in the lower Niagara River, and at Cape Vincent, N.Y., at the head of the St. Lawrence River. Temperature and velocity structure will be examined for North and South Wolfe Island sections and for the Clayton - Gananoque area of the river. The temporary analog water temperature recorder at Clayton will be replaced with a permanent digital water temperature recorder similar to the Cape Vincent and Lewiston installations.

Savonious rotor current meter systems used in the water velocity studies will be calibrated, as they come out of the field, at the Ship Hydrodynamic Laboratory, University of Michigan. After calibration, any current meter system found to be in need of adjustment or repair will be put in good order and recalibrated. A calibration report will be furnished to all persons who made use of the systems during the past field season. The digital water temperature recorders have had only an initial calibration at the time of installation. Each water temperature recorder now in operation will be recalibrated, and confidence limits will be established. Before recalibration, all data from these recorders are considered to be provisional. Heat-flow tabulations will continue, and preliminary advection estimates will be made for selected periods.

19. *Occurrence and Transport of Nutrients and Hazardous Polluting Substances in the Genesee River Basin*

Principal Investigator: L.J. Hetling - New York State Department of Environmental Conservation

The biweekly stream-sampling program is on schedule and will concontinue during the next quarter. Samples are being sent to G.F. Lee. At the end of January and during the spring thaw period, additional samples will be collected from each site and analyzed for mercury,

cadmium, zinc, lead, copper, nickel, manganese, chromium, fluorides, and pesticides. Sediment samples will also be collected from each of the nine sampling stations during this period.

Development of computer programs for data storage, printout, and analysis has begun.

20. *Boundary Layer Flux Synthesis*

Principal Investigator: J.A. Almazan - CEDDA/NOAA

The Texas Instruments meteorological buoy and tower data for July 7-21 have been processed and edited. Hourly averages of air temperature, dew-point temperature, sea-surface temperature, and wind speed and direction have been computed. Estimates of momentum, heat, and moisture flux have been obtained for July 14-21. Synoptic analyses for the same period are available and are being combined with the buoy data.

21. *Hazardous Material Flow*

Principal Investigator: N.A. Jaworski - EPA

No report.

22. *Remote Measurement of Chlorophyll With Lidar Fluorescent System*

Principal Investigator: H.H. Kim - NASA

No report.

23. *Inflow/Outflow Term - Terrestrial Water Budget*

Principal Investigator: I.M. Korkigian - U.S. Army Corps of Engineers

Lake Ontario outflows have been computed and checked against the St. Lawrence flows as reported by Ontario Hydro in the St. Lawrence River Weekly Summary of Flows, Levels, and Temperatures. The data are ready for submission to the IFYGL Data Bank, and the final report on the measurements is being prepared.

24. *Use of an Unsteady-State Flow Model To Compute Continuous Flow*

Principal Investigator: I.M. Korkigian - U.S. Army Corps of Engineers

Work has not begun.

25. *Radiant Power, Temperature, and Water Vapor Profiles Over Lake Ontario*

Principal Investigator: P.M. Kuhn - ERL/NOAA

Work completed.

26. *Algal Nutrient Availability and Limitation in Lake Ontario*

Principal Investigators: G.F. Lee, N.Sridharan,and W. Cowen - University of Wisconsin

Samples of the major tributaries to Lake Ontario have been tested for nutrient limitation by the standard AAP test and by C-14 uptake tests with nutrient spikes. The effect of phosphorus removal, by alum treatment of lake water, on the growth of natural lake algae is being studied. Genesee River basin samples are being tested for nitrogen and phosphorus in selected samples with high particulate P and N concentrations. Direct algal growth bioassays, with particulate matter as the only phosphorus source, have been used for urban runoff and Genesee basin samples.

Progress on this project has been good and more or less in accord with the original plan. All data collected during the summer are being compiled in a preliminary report form, to be completed during the next quarter.

27. *Wave Studies*

Principal Investigator: P.C. Liu - LSC/NOAA

Four waveriders located near U.S. buoys 14, 17, 19, and 20 were in operation from the beginning of the quarter until mid-November when all gages were retrieved according to schedule.

Selected periods of wave data recorded from the four waveriders were analyzed on the UA-10 Spectrum and 1010 Spectrum Averager. Several storm periods were recorded, and correlations among the waveriders were good.

Analysis of wind and wave data from multiple-channel recordings on the Oswego research tower had to be postponed because the analog-to-digital converter at the Lake Survey Center was still nonoperational.

28. *Cloud Climatology*

Principal Investigator: W.A. Lyons - University of Wisconsin, Milwaukee

We are planning to continue data collection until June 1, 1973, since data needed for a year-long climatology can be obtained in suf-

ficient amounts to warrant this from our point of view. We are also continuing to catalog daily Service A Teletype and NWS NAFAX facsimile products. ATS satellite photography is being obtained once daily. ERTS-1 photography, which covers parts of the IFYGL area about 6 or 7 days per month, is also being received and cataloged. Plans will be developed for reducing the solarimeter traces and various all-sky pictures.

Refunding from NSF has been sufficient to allow us to send technicians to the camera sites to correct malfunctions. We hope to be able to approach 80-percent data collection efficiency from the cameras by around March 1, and continue to do so for 3 more months. The insolation traces from the two solarimeters, after a long delay in shipment, are arriving, and a first look at the data indicates few breaks and proper operation of the equipment. As of February 15, two camera systems, at Oswego and Rochester, N.Y., have been put back into operation. The quality of the pictures has been exceedingly good, as have the ship panoramics, which are being received on an irregular basis (roughly one per day). During January, the Scarborough 16-mm system produced excellent time-lapse movies, but a camera component broke down; it is now being repaired. Two of the 35-mm Nikon cameras were completely overhauled, which, hopefully, will help considerably. The almost incredibly good quality of the ERTS-1 imagery over the area will be invaluable for calibrating NOAA-2 and ATS satellite images. We have found excellent views of lake breeze clouds and well-organized lake snow-squall systems, as well as other interesting phenomena.

29. *Zooplankton Production in Lake Ontario as Influenced by Environmental Perturbations*

Principal Investigator: D.C. McNaught - State University of New York at Albany

No report.

30. *Change in Lake Storage Term - Terrestrial Water Budget*

Principal Investigator: R. Wilshaw - U.S. Army Corps of Engineers

Incoming data continue to be cataloged and stored. End-of-week and end-of-month unadjusted lake levels were determined. No further work was accomplished for writing a gage correlation program, or performing a gage inspection before the close of the open-water season. It is anticipated that by March 1973 some progress can be reported on initial computer analysis of gage correlations. When results are available, they will be coordinated with our Canadian counterparts.

31. *Soil Moisture*

Principal Investigator: L.T. Schutze - U.S. Army Corps of Engineers

Work has not started. It will be reconsidered during the next quarter. The water storage on the surface and below the surface of the ground will probably be determined as a single storage factor from the land-water balance equation.

32. *Testing of COE (Corps of Engineers) Lake Levels Model*

Principal Investigator: E. Megerian - U.S. Army Corps of Engineers

Work on this task will start around April 1973.

33. *Nearshore Study of Eastern Lake Ontario*

Principal Investigator: R.B. Moore - State University of New York at Oswego

No report.

34. *Internal Waves - Transects Program - Interpretation of Whole-Basin Oscillations*

Principal Investigator: C.H. Mortimer - University of Wisconsin, Milwaukee

Between October 2 and 6, the *Researcher* and the *Advance II* steamed along transect lines crossing the long axis of the lake, one in the central part and one in the eastern end. The undulating fish, developed by the Center for Great Lakes Studies (CGLS), was used aboard the *Researcher* to measure temperature vs. depth at intervals of roughly 1.5 n mi. Mechanical BT's were used on the *Advance II* to measure temperature vs. depth at 18 stations across the lake.

Reduction of all data sets is still in progress. Almost all the MBT data have been transferred to cross-sectional plots of isotherm depths, one plot for each transect. Manual cross-sectional plots from some of the CGLS undulator records have been produced for the second transect cruise, August 7 to 11. They await final drafting and reproduction. The undulator data recorded digitally on magnetic tape have proved to be somewhat more difficult to handle.

35. Pontoporeia affinis *and Other Benthos in Lake Ontario*

Principal Investigator: S.C. Mosley - University of Michigan

During a cruise aboard the *Advance II*, November 8 to 10, along the Cobourg and Mexico Bay transects, a limited study of day vs. night occurrence of large Crustacea in bottom grab, sled, and plankton net samples was made at stations CO-25 and MB-20. Sampling planned for mid-January on the *Limnos* will provide more complete coverage of the reproductive cycle of *Pontoporeia* than previously achieved.

Summer samples were completely processed to the primary data stage.

The device on the sled that measures the actual distance along the bottom from which a sample is obtained was modified so that the counter wheel is free to rotate only when the sled is in contact with the bottom.

36. *Pan Evaporation Project*

Principal Investigator: T.J. Nordenson - NWS/NOAA

Progress has been satisfactory except for some delay in installation of heating elements in X-3 pans and a temporary lack of power supply at Fort Niagara and Hilton. The project is proceeding reasonably close to plan, although there is a delay in obtaining dew point and radiation from collocated IFYGL land meteorological stations. This is not unexpected because of the large data collection program at these sites.

Basic data tabulations have been postponed until dew-point and radiation data from IFYGL land meteorological stations become available. The tabulations will then contain all data necessary to compute evaporation by the four methods proposed for this project.

37. *Simulation Studies and Other Analyses Associated With U.S. Water Movements Projects*

Principal Investigators: J.P. Pandolfo and C.A. Jacobs - CEM

Two reports have been completed. The first, "Numerical Simulations of Lake Ontario With a One-Dimensional Air/Lake Model," was mailed to the IFYGL Project Office in October. It describes the results of simulations for three 4-day periods of climatologically "typical" conditions of March, July, and October.

The second report, on which the major effort was spent, is a detailed documentation of the three-dimensional model that will be used to simulate the circulation of Lake Ontario. The report will be issued in two volumes: "A Description of a General Three-Dimensional Numerical Simulation Model of Coupled Air-Water and/or Air-Land Boundary Layer" (Vol. I) by C.A. Jacobs, and "FORTRAN Program and Input Specifications"

(Vol. II) by Joseph A. Sekorski. During preparation of this report several inconsistencies were discovered in the approximation of analytic formulas by finite-difference formulas. The analytic equations, the finite-difference techniques, and the FORTRAN program used in the construction of this complex numerical model were examined in detail.

38. *Structure of Turbulence*[1]

Principal Investigator: H.A. Panofsky - Pennsylvania State University

Wind-speed records for 37 runs at two levels at three towers were delivered by Thornthwaite Associates, each about 1 hour long. About half are also on magnetic tape. Some of the strip charts were read and compared with the digitized magnetic tapes. Preparations were made for cross-spectral analysis of wind-speed fluctuations.

Time series were plotted from some of the Canadian buoys; at times, wind speeds showed strong fluctuations with periods of about 100 min. Wind directions were "noisy".

Coherence and spectral information for many runs will be available, and will be analyzed as functions of wind speed, lapse rate, angle between anemometer lines and wind speed, and relative level of turbulence. Preliminary results are very encouraging. Cospectra will be obtained between buoy wind speed and direction to get some information on vortex structure.

39. *Airborne Snow Reconnaissance*

Principal Investigator: E.L. Peck - NWS/NOAA

Background flights were completed for all survey lines on October 11 and 13, 1972. Soil moisture was measured along the three calibration lines, and D. Weisnet, National Environmental Satellite Service (NESS), arranged for aerial radiometer sensors to be flown by the National Ocean Survey (NOS) at the same time over the lines to test the use of the sensors for measurement of soil moisture conditions.

The soil moisture data and other ground truth information for the June and October flights were published in December 1972 in "Interim Report #1, Airborne Snow Reconnaissance." The report covers the following:

[1] This task was previously entitled "Tower Program".

(a) Soil moisture data.
(b) Maps of soil types.
(c) Description of soil types.
(d) Topographic maps.
(e) Aerial photographs.
(f) Vegetative conditions.
(g) Location of sampling points for the three calibration lines.

Three snow survey flights are scheduled for the January-March quarter. Because of lack of snow, the first of these, originally set for around January 15, is being postponed. Interim reports on ground truth measurements for these surveys will be prepared and will contain measurements of snow depths, water equivalent, and soil moisture.

As an aid in evaluating snow and soil moisture conditions during the year, a precipitation gage was installed near the center of the Fleming-Scipio Center calibration line.

40. *Optical Properties of Lake Ontario*

Principal Investigator: K.R. Piech - Calspan Corporation[2]

Nine week-long cruises have been conducted on the *Researcher* since May 1, 1972, the last one during the week of November 27. Surface observations have consisted of transmissometer measurements of total attenuation/length, with peak instrument sensitivity in the green region; and upwelling and downwelling irradiance measurements of photic zone depth and diffuse attenuation with narrow-band red, green, and blue filters.. Secchi disk readings by the ship's crew were also recorded. Data were collected at some 30 stations during each cruise. Approximately one-third of the data has been reduced and is ready for analysis.

The aerial measurement program has also been completed, with the last of seven flights made on November 17. Data have been obtained in 70-mm Ektachrome MS2448 format on monthly transects from an altitude of 10,000 ft. Shoreline imagery allowed removal of atmospheric and spectral reflectance in the red, green, and blue bands. Preliminary examination of the aerial data suggests the existence of periodic turbidity fluctuations along the north-south axes of the lake. Imagery on a smaller physical scale has revealed the occasional presence of turbidity bands several hundred yards wide and about 1 mi long, as well as possible organic surface slicks modifying capillary wave action. The latter are an important part of interfacial transport phenomena.

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[2] Formerly Cornell Aeronautical Laboratory.

The most common optical parameters measured at the surface are attenuation/length and photic zone depth, while aircraft measurements yield spatial representation of volume reflectance in the three spectral bands of color film. Fundamental comparison of surface and aerial data thus rests on the relation of volume reflectance to the parameters attenuation/length and photic zone depth. Preliminary analyses suggest that the aerial data can be reduced to relative attenuation/length and relative photic zone depths in the three bands. Detailed investigation and corroboration over the next year will be undertaken, since verification would constitute a major advance in the use of aerial photometry in limnologic studies.

41. *Storage Term - Energy Balance Program*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

42. *Sensible and Latent Heat Flux*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

43. *Thermal Characteristics of Lake Ontario and Advection Within the Lake*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

44. *Oswego Harbor Studies*

Principal Investigator: G.L. Bell[3] - LSC/NOAA

Twelve cruises were conducted during the quarter, the last on November 11. With the exception of calcium, all water sample analyses for major ions are complete. Computer reduction and verification is in progress. Major factors determining the diffusion patterns are streamflow, wind, alongshore currents and temperature differences between the inflow and the receiving lake water.

Temperature data have had to be manually digitized and keypunched; most of them have been reduced.

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[3] G.L. Bell has replaced A.P. Pinsak as principal investigator on this task.

45. *Mapping of Standing Water and Terrain Conditions With Remote Sensor Data*

Principal Investigator: F.C. Polcyn - University of Michigan

ERTS-1 coverage of the 32,000 mi^2 Lake Ontario basin is being used to study short-term and seasonal changes that affect many water problems in the Great Lakes area. Processed ERTS-1 imagery is contributing to the data base of synchronized observations by many United States and Canadian investigators for a coordinated, synoptic study of the Ontario basin. The first set of ERTS-1 data will be processed shortly for parameters of hydrological and limnological significance: land use, terrain features, and water quality. Eight frames recorded during a mostly clear period (August 19 to 21) provide coverage of most of the basin. Many drainage basin characteristics can be clearly identified in the imagery.

Work to date includes (1) construction and interpretation of image mosaics for the Ontario basin, (2) preliminary processing of aircraft scanner data to simulate and test schemes for computer processing of ERTS-1 data, and (3) initial digital analysis in two spectral bands of ERTS-1 data for the Rochester test site.

46. *Remote Sensing Program for the Determination of* Cladophora *Distribution*

Principal Investigators: F.C. Polcyn and C.T. Wezernak - University of Michigan

Multispectral and photographic coverage was obtained on July 31 by the Willow Run Laboratories' remote sensing aircraft from an altitude of 2,000 ft. Data were collected along the U.S. shore from Niagara to Stony Point at the eastern end of the lake. Scanner and photographic data from this mission and the earlier flight on June 20 are being processed. Computer processing of the data has begun.

Computer processing of data for a section of the New York shoreline was completed, and the areal extent of *Cladophora* beds was measured. A color digital map showing land, sand, and *Cladophora* beds out to 1,000 ft from shore was produced.

At a meeting of the IFYGL Biology-Chemistry Panel in Niagara Falls, plans for spring 1973 were formulated and copies of ground truth data assembled by R.A. Sweeney and R.B. Moore were received and reviewed. The computer map was displayed at the meeting and generated much interest in the technique used in preparing it.

47. *Remote Sensing Study of Suspended Inputs Into Lake Ontario*

Principal Investigators: F.C. Polcyn and C.T. Wezernak - University of Michigan

No report.

48. *Island-Land Precipitation Data Analysis*

Principal Investigator: F.H. Quinn - LSC/NOAA

Precipitation data were collected continuously at the six Lake Ontario stations. Data tapes through December 1972 are being reduced. Tabulated precipitation data are available for 1971 and will soon be available for 1972. The data collection and reduction programs are on schedule; collection will continue.

49. *Lake Circulation, Including Internal Waves and Storm Surges*

Principal Investigator: D.B. Rao - University of Wisconsin, Milwaukee

No report.

50. *Atmospheric Water Balance*

Principal Investigator: E.M. Rasmusson - CEDDA/NOAA

The field phase of this project, which consisted of rawinsonde observations from a six-station network along the perimeter of the lake, ended on December 9, 1972. Software development for processing the data from these observations continued during the quarter. The following "A" process computer programs were designed, tested, and implemented:

(1) Dump of the original tapes.
(2) Copying these tapes into a cleaned-up version.
(3) Translating headers and unpacking and time-correlating the meteorological and Loran data.
(4) Plotting the time-correlated data in frequencies and engineering units for meteorological data and time differences and u and v components for Loran.

During the field operations, the "A" process software was used mainly for monitoring. Upon delivery of tapes every 2 or 3 weeks, the last tape recorded at each station was run through the above programs. Analysis was also begun on the "B" process software. This set of programs, in which the translated time-correlated data are used, will:

(1) Edit and average the data.
(2) Perform sounding computations.
(3) Generate adiabatic plots on microfilm.

Development has continued on the orthogonal function analysis scheme. Software development has progressed to the point where the mass budget analysis can be performed. Tests of the BOMEX data indicate excellent agreement with previous computational techniques. Confidence limits for the derived quantities are also being calculated, and are found to be consistent with independent estimates. Preliminary studies were made of area-averaging techniques suitable for general areas defined by irregular boundaries.

51. *Evaporation Synthesis*

Principal Investigator: E.M. Rasmusson - CEDDA/NOAA

The pilot study of 2 weeks of TI data collected in July, which is being coordinated with the Boundary Layer Flux Synthesis Task, continued during this quarter. See report for Task 20.

52. *Ground-Water Flux and Land Storage*

Principal Investigator: E.C. Rhodehamel - U.S. Geological Survey

Data collections from the water wells distributed throughout the basin continued. Graphic charts from these wells with continuous recorders have been used for analysis. The remaining wells are measured weekly or monthly.

53. *Spring Algal Blooms*

Principal Investigator: A. Robertson - IFYGL Project Office/NOAA

EPA's Rochester Chemistry Laboratory has completed the sample analysis.

54. *Ice Studies for Storage Term - Energy Balance*

Principal Investigator: F.H. Quinn - LSC/NOAA

Collection and reduction of solar radiation, air temperature, and wind speed and direction data from the Mexico Bay meteorological station is continuing. A computer program for presenting meteorological data was completed. An air temperature sensor and recorder was reinstalled.

55. *Lagrangian Current Observations*

Principal Investigator: J.H. Saylor - LSC/NOAA

During the first half of October current measurements were completed in eastern Lake Ontario, in the middle of the lake basin. Oscillatory motions associated with internal waves of near-inertial periods were dominant. All current trajectories have been plotted, and cross sections of water temperature distribution are being prepared.

56. *Circulation of Lake Ontario*

Principal Investigator: J.H. Saylor - LSC/NOAA

Compilation of comparative current measurements made near the buoys is complete. These data will be useful in editing and verifying buoy current records.

57. *Phytoplankton Nutrient Bioassays in the Great Lakes*

Principal Investigator: C. Schelske - University of Michigan

No report.

58. *Runoff Term of Terrestrial Water Budget*

Principal Investigator: G.K. Schultz - U.S. Geological Survey

Discharge was measured at two crest-stage gages to verify old ratings. Field visits were made to some of the sites to obtain stages for checking the stability of the established correlations between the gaged and ungaged areas. Except for the areas in the Erie Barge Canal region, correlations have been completed.

59. *Coastal Chain Program*

Principal Investigator: J.T. Scott - State University of New York at Albany

Once the data reports have been assembled, we will begin studies of coastal transport processes and coherence of velocity between coastal chains. The reports are due in early 1974, but we are a bit ahead of schedule. Some of this work will be included in the IAGLR report, and the transport analysis has already begun.

I will meet once more with Gabe Csanady or Bert Pade of the Canadian coastal chain group to discuss the coherence study; Csanady and I have looked at some of the data.

We are working with Dave Drury of NOAA on getting the data into the IFYGL data bank. Cards have been punched, but we are waiting for word on whether our computer tape will be compatible with CEDDA equipment. Many requests for our data are being received,and in lieu of the reports we should perhaps have the data in CEDDA storage as soon as possible.

The third coastal chain alert period, September 15 to October 15, was by far the poorest of the three in terms of amount and quality of data collected. Usable data were obtained on only 35 percent of the possible days. Progress on four reports, one on each of the coastal chain and one on a special Rochester embayment study, is good. Estimated date of printing is April 10, 1973.

Drafting of the cross sections of temperature and alongshore velocity will be completed in late February.

It was agreed with Csanady that I would report on the general aspects of the coastal chain results at the IAGLR meeting in April.

Summary of coastal chain data record and causes of unusable runs for the third alert

	Oswego	Rochester	Olcott
Days of alert	30	30	30
Possible runs	40*	60	60
Runs attempted	14	17	24
Usable runs completed	10	12	21
Usable full days completed	-	3	7
Usable days (one or more usable runs)	8	10	13
Unusable runs	30*	48	39
Reasons:			
Weather	27*	35	35
Fog	0	0	0
Rough sea	27*	35	35
Equipment failure	3	8	2
Meters	0	0	0
Boats	3	8	2
Crew	-	5	2

* Crew was not full time for entire period.

60. *Analysis of Phytoplankton Composition and Abundance*

Principal Investigator: E.F. Stoermer - University of Michigan

Analysis of field samples is almost complete,and data are being prepared for automated plotting and final reduction. We have not yet been able to inspect correlations (R) of the Lake Ontario particle count (P.C.) data relative to our own microscope cell counts and EPA chlorophyll data. How soon this will be done depends partly on how soon the EPA chlorophyll data become available.

We have recently had the opportunity to inspect the correlations in another data set of comparable size,and the values given below are suggested as the probable range for the Lake Ontario data.

Cruise	R-cells/ml-Chlorophyll	R-cells/ml-20-40μ P.C.	R-chloro-20-40μ P.C.	R 99%
April	0.8229	0.5075	0.3800	0.30
May	0.6547	0.7722	0.8042	0.28
June	0.9185	0.8626	0.9033	0.28
July	0.7430	0.7212	0.7295	0.28
Overall Apr.-Nov.	0.6428	0.6131	0.6485	0.10

These results suggest that, although the overall correlations are not as close as might be desired, the particle count data compare favorably with the other two independent measures of phytoplankton abundance and should be useful in showing trends between stations.

Perhaps the most interesting qualitative result that has shown up in our data is an apparent consistent low in phytoplankton abundance at stations in the vicinity of Toronto. This is quite opposite to the expected result and suggests that chemical data from this region should be inspected for the possibility of toxic factors.

61. *Clouds, Ice,and Surface Temperature*

Principal Investigator: A.E. Strong - NESS/NOAA

Collection of satellite data continues on a regular basis. Selected thermal IR data will be processed to yield surface temperature analyses of Lake Ontario.

Satellite data collected are shown in the table that follows. All picture products are available through Documentation Service, NOAA/NESS, FOB#4, Rm. 1167, Suitland, Md. 20233.

Dates	Satellite	Wavelength	Resolution	Time (local)	Data imagery	Tape
Apr.-Oct.	ESSA-9	0.5- 0.7 μm	2.0 mi	1400	Yes	Yes
Nov.-Dec.	NOAA-2	0.5- 0.7 μm	2.0 mi	0900	Yes	Yes
Dec. only	NOAA-2	10.5-12.5 μm	5.0 mi	0900/2100	Yes	No
Dec. only	NOAA-2	0.6- 0.7 μm	0.5 mi	0900	Some	No
Dec. only	NOAA-2	10.5-12.5 μm	0.5 mi	0900/2100	Some	No
Aug.-Dec.	ERTS-1	Four channels: 0.5- 1.1 μm	300 ft	0930	Yes	[NASA]

62. *Analysis and Model of the Impact of Discharges From the Niagara and Genesee Rivers on Nearshore Biology and Chemistry*

Principal Investigator: R.A. Sweeney - State University of New York at Buffalo

No report.

63. *NCAR/DRI - Buffalo Program*

Principal Investigator: J.W. Telford - Desert Research Institute, University of Nevada

No report.

64. *Mathematical Modeling of Eutrophication of Large Lakes*

Principal Investigator: R.V. Thomann - Manhattan College

The primary effort during the third quarter was preliminary work on the conception of a vertically layered phytoplankton model that includes nutrient limitation and predation. The model is now structured with three vertical layers and nine interactive systems. A 10th system, which represents a conservative tracer, is used to analyze the dispersion and transport phenomena. The vertical layers represent the epilimnion, hypolimnion, and the benthos. Stratification of the lake is done by temporally varying the vertical dispersion. This enables the epilimnion to establish itself in the spring, since the vertical dispersion is given a value of zero during the stratification period. For the other periods of the year the vertical dispersion is incorporated to allow exchange between segments. The biological systems are the phytoplankton and zooplankton systems. The nutrient systems include organic nitrogen, ammonia nitrogen, nitrate nitrogen, organic phosphorous, and inorganic phosphorous. Carbonaceous biochemical oxygen demand and

dissolved oxygen deficit are the remaining interactive systems. Phytoplankton growth is dependent on the nutrient concentrations, solar radiation, temperature, photoperiod, light extinction coefficient, endogeneous respiration, and zooplankton grazing. Preliminary compilation of bathymetric data, nutrient loading inputs, and initial conditions required by the program has begun.

Plans for the next quarter include final debugging of the above model and carrying out preliminary runs to investigate the various systems. Gathering of a more complete data set for the nutrients is also planned. Data will be grouped according to depth intervals and will be displayed temporally.

65. Cladophora *Nutrient Bioassay*

Principal Investigator: G.F. Lee and W. Cowen - University of Wisconsin

See Task 26.

66. *Sediment Oxygen Demand*

Principal Investigator: N.A. Thomas - EPA

No report.

67. *Main Lake Macrobenthos*

Principal Investigator: N.A. Thomas - EPA

No report.

68. *Current Levels of Chlorinated Pesticides and Polychlorobiphenyls (PCB's) in Fish and Water From Nine Regions of Lake Ontario*[4]

Principal Investigator: G. F. Lee - University of Wisconsin

Sample collection and processing of samples up to gas chromotographic/mass spectrometer examination was completed for all samples that will be used in the initial phase of this project. Some fish samples that had been cleaned up were processed through preliminary gas chromotographic examination for chlorinated hydrocarbon pesticides.

[4] The title of this task has been changed.

69. *Basin Precipitation - Land and Lake*

Principal Investigator: J.W. Wilson - CEM

Of primary importance during the quarter was the establishment of a network for measuring snowfall over Oswego and Camden counties in the heavy snow belt east of Lake Ontario. R.B. Sykes of the University of New York at Oswego is heading this project. Thirteen recording gages were installed in coniferous forests, well-protected from the wind. E. Peck, L.W. Larson, and D. Quick of the National Weather Service aided greatly in choosing appropriate sites. Approximately 60 observers have been recruited to measure snow depths and water equivalents. Several of them will also collect snowflake samples. The recording gages became operational in early December, and the observations began in early January. It is expected that this program will prove extremely valuable in establishing procedures for measuring snowfall by radar.

During periods of precipitation, Buffalo successfully collected data 82, 84, and 79 percent of the time in October, November, and December, respectively. A computer routine has been prepared for skipping over bad data on the raw tapes. A number of these tapes that previously could not be read because of intermittent tape errors are being reprocessed, which should improve the data collection figures previously given.

At Oswego, data were successfully collected on tape almost 100 percent of the time. However, there was a 7-day period in November when a faulty electronic board in the Video Integrator Processor (VIP) caused intermittent errors in the data.

Removal of the $1/R^2$ range normalizing circuit from the Oswego radar, in November, has greatly improved the radar's ability to detect light snow. Range normalizing is accomplished with the Hour Accumulation Program. Editing, error-checking, and compacting of the Oswego raw radar data is on schedule (Data Set 1), and it is expected the same will be true shortly for the Buffalo data.

Hourly rainfall totals (Data Set 2) have been derived from the Oswego data for May 11 through May 31, June 16 through July 19, August 12 through September 9, and October 2 through December 7; from the Buffalo data, for August 29 through October 24.

Further studies of procedures to integrate data from all three radars and all rain gages to obtain watershed and lake precipitation totals were delayed for two reasons: (1) the Canadian effort to obtain precipitation measurements from their Woodbridge radar is running behind schedule; and (2) more effort was required to generate Data Sets 1 and 2 than originally anticipated.

A program is currently being developed to extract rainfall totals from recording gages and climate gages within 120 mi of the Buffalo and Oswego radars. Data from these gages were provided on magnetic tape by the National Climatic Center.

70. *Evaluation of ERTS Data for Certain Hydrological Uses*

Principal Investigators: D.R. Weisnet and D.F. McGinnis - NESS/NOAA

No report.

71. *Distribution, Abundance, and Composition of Intertebrate Fish-Forage Mechanisms in Lake Ontario*

Principal Investigator: J.F. Carr - Great Lakes Fisheries Laboratory

Sample acquisition is complete, as reported in Bulletin No. 5.

Alewife food habits - no progress.

Smelt food habits - Specimens have been prepared for examination and stomach analyses have begun. Stomachs of many fish collected in daytime were empty. The food found was composed of *Mysis relicta* and cyclopoid and calanoid copepods (fish collected in the spring at the west end of the lake).

Crustacean zooplankton - Survey of samples for organism types is one-third complete. This has resulted in permanent microslide mounts, and identification to, or near, species. *Limnocalanus macrurus* and *Diaptomus sicilis* are abundant in spring and midsummer. *Daphnia* do present a problem.

72. *Coastal Circulation in the Great Lakes*

Principal Investigator: G.T. Csanady - Woods Hole Oceanographic Institution

Between September 1 and November 30, work was concentrated on data from the north-shore coastal chains and supporting information obtained during the spring alert period, May 15 to June 15, which covered the formation and eventual disappearance of both "wedge-shaped" and "lens-shaped" spring thermocline structures.

One outstanding feature of the data was the considerable reduction and occasional complete disappearance of wind stress when the air passed from the warm nearshore band to the cold lake center. This particular form of air-sea dynamic coupling is of considerable general significance

in many problems of ocean dynamics, although it is rarely taken into account. The underlying micrometeorological facts - that air blowing over a cold surface becomes stable - are well known in general, but no quantitative method exists for predicting the influence of air-sea temperature contrast on sea-level wind stress, given gradient level wind speed and air temperature. A theoretical model of the planetary boundary layer with an inversion lid has therefore been constructed. It predicts, in fair accord with observations on Lake Ontario, that the ground level stress drops more or less abruptly to zero when the air-water temperature contrast rises to a value of the order of 10°C, the actual value being dependent upon geostrophic wind. This study is almost ready to be submitted for publication; after internal review at WHOI it will be mailed to NOAA's IFYGL Project Office.

Attention has also been given to the occurrence of some well-defined wind-stress impulses with clearly identifiable consequences on the momentum of the warm nearshore band of water. A completely unexpected finding was that momentum easily passed downward without significant mixing or heat transfer across the thermocline, when the latter was quite stable. This study should be ready for publication soon.

Further preliminary studies were made of the "roughness" of the sea surface in relationship to wind speed and of the excitation of transverse internal seiches in large, oblong lakes. These are expected to improve the theoretical framework for interpreting observed evidence.

73. *Lake Water Characteristics*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

74. *Snow Observation Network*[5]

Principal Investigator: R.B. Sykes - State University of New York at Oswego

This task was initiated as an adjunct to the IFYGL Oswego area weather radar operation. The snowfall network is supplemental to the Rochester precipitation network, which has served for certain ground-truth purposes since the three IFYGL radars began regular operation. Equipment responses and distance considerations necessitated the new arrangements for ground-truth snowfall information. Also, snowfall conditions are usually very much lighter in the Rochester, N.Y., area than northeast, east, and southeast of Oswego.

[5] This is a new task initiated in November 1972.

The objective of this task is to develop and operate a small-scale network of winterized precipitation gages over about 1,000 mi^2 east-northeast, east, and east-southeast of the radar site at Granby Center (about 10 n mi south of Oswego) and to supplement this network for weather observations, water content measurements, and ice crystal-snowflake descriptions.

Gage sites were planned across and along the "typical axes" of expected snowfall, based upon experience gained during past winters. Staff and local personnel surveyed locations for 13 conventional precipitation gages, 12 supplied by NOAA and 1 through Oswego resources.

Five contiguous school districts from south to north were contacted, and arrangements were made for students working under local monitors to become weather and snowfall observers. Observer locations and the gages are all located at a distance of more than 8 to 10 n mi from the Oswego radar. The network includes some locations as far out as 36 to 40 n mi, with the density controlled partly by the resources available to support this task, partly by the time that would be available to make the network ready for operation, and partly by the expected number of reliable students. Although the basic radar equipment can detect precipitation targets at almost zero range, the video integrator and processor (VIP) unit automatically blanks out all returns from zero range, out to about 10 n mi. Since it is this integrated video output that is passed to the recorder-digitizer no data from the inner 10-n mi circle could be placed on magnetic tape. Neither could any data from this area be recorded on the regular 5-min interval remote PPI scope pictures, since this presentation, with the exception of a limited number of unscheduled exposures, also displays integrated video (contour mode) rather than raw (normalized or non-normalized) video.

Circumstances prevented full activation of the network before the middle of January 1973. The winter of 1972-73 is already somewhat of a legend. There has been a dearth of heavy snowfall within the area; the heaviest, of short duration, was right at the radar site, and thus could not be studied because of equipment characteristics. By the end of February the program had provided the following:

(a) Some 3,000 observation forms, about 80 percent of which indicated no significant ongoing or recent snowfall at times of observations.

(b) Some useful snowflake samples and photographic records.

(c) Nearly 100 percent complete and readable gage records, many with accompanying supplemental information.

(d) Some promising reconnaissance material within one school district, including snowcover depth and photo records of flakes and crystal types.

Compared with the previous five winter seasons, major lake effect and general storm situations have been fewer.

Boundary Layer - J.Z. Holland, U.S. Panel Cochairman

Two U.S. aircraft - NOAA's RFF DC-6 39C and NCAR's Buffalo - participated in the Boundary Layer Panel's fifth and final observation period, November 11 to 22, 1972. The period was characterized by a cold outbreak, and at times the air temperature was nearly 10°C colder than the lake surface water temperature. Estimates of heat and moisture fluxes were made based on data collected by the 39C 100 ft above the lake. Standard meteorological data were also collected at various altitudes.

The U.S. meteorological buoys were retrieved during November, restricting continued surface measurements to the Canadian network.

CEDDA has begun analysis of time and space variations of stress, evaporation, and heat flux based on U.S. and Canadian buoy data. These preliminary analyses were discussed at the Evaporation Synthesis meeting in Toronto in November 1972.

Terrestrial Water Budget - B.G. DeCooke, U.S. Panel Cochairman

During the reporting period emphasis was placed on reduction and correlation of data provided by the various task efforts. As before, several tasks had to be temporarily shelved because of delays in receiving data and shortages of manpower.

First-cut estimates of lake evaporation for May, June, and July were given in Bulletin No. 5. Estimates (in inches) for August through November are as follows: August, 3.6; September, 3.8; October, 5.2; and November, 2.7.

Field work in most areas has been done, except for snow and Niagara River inflow evaluation. Snow surveys will be completed during the first quarter of 1973, but the Niagara River study will continue until May, when the sonic-flow meter will be calibrated. This was not possible during the Field Year because of equipment failure.

Synthesis Program

Twenty-five major categories of user requirements have been identified and ranked in terms of priority. Parameters or phenomena of interest for each have been listed. The 11 top priority categories have been studied in detail, and a table has been prepared of specific problems related to the lake environment, the source of each problem, the principal variables of interest, the space and time scales of concern, and the types of primary and secondary models needed for alternative solutions. This has been done to help guide the IFYGL Project Office in modeling work to be done as a part of the analysis phase of the IFYGL program.

John Bennett of the IFYGL Project Office is developing a numerical model for prediction of lake currents and temperature. The model will be used to test the consistency of the lake measurements with the estimated surface fluxes of heat and momentum and to simulate the effect of wind and heat flux on the circulation of water and diffusion of dynamically passive substances. The model has been formulated, programmed, and is being checked out.

Climatic data collection is continuing on the Great Lakes for use in the analysis phase.

U.S. Field Headquarters

Under the operational control of the U.S. Field Headquarters for IFYGL at Rochester, N.Y., the major U.S. systems continued to be used for observations through December. Windup of Field Headquarters activities began early in December after the departure of the *Researcher* and *Advance II* and proceeded essentially as planned. Office space was reduced in mid-December to support only the maintenance and operation of the Texas Instruments land and island stations, with Lt. Jerry Crowley, NOAA, as Officer in Charge.

Ship Operations

The ship operations continued in accordance with the IFYGL Technical Plan.

The NOAA ship *Researcher* conducted scheduled lake temperature cruises using electrobathythermographs, biological-chemical cruises using a Rosette water sampler, and one transect cruise for internal wave studies. Gravity and magnetic surveys were also made for W.H. Diment of the University of Rochester, and observations of additional lake water characteristics for A.P. Pinsak of NOAA's Lake Survey Center. The IFYGL Field Headquarters supplied shallow-water XBT's (expendable bathythermographs) to ensure successful temperature measurements despite poor weather conditions or equipment malfunctions. After a combined lake temperature and biological-chemical cruise on December 1, the *Researcher* departed for Miami, Fla., on December 2.

The Cape Fear Technical Institute's *Advance II* conducted lake temperature cruises using electrobathythermographs, one transect cruise with closely spaced BT casts for internal wave studies, and benthos cruises on which bottom samples were collected with a Ponar grab sampler. Following the lake temperature cruises, six inshore temperature surveys were made for J.T. Scott, the State University of New York at Albany. When poor weather delayed operations, the *Researcher* assisted in assuring completion of scheduled lake temperature cruises. The *Advance II* completed operations on December 2 and left the same day for Wilmington, N.C.

The research vessel *Kaho* of the Great Lakes Fisheries Laboratory, U.S. Department of Interior, completed fish population studies on October 26 and returned to Lake Michigan. The Lake Survey Center's *Shenehon* finished the harbor studies program and departed on November 24 for Detroit, Mich. The survey vessel *Johnson* wound up support operations for the Texas Instruments system stations and other IFYGL programs on December 2 and departed for Detroit, Mich., the following day. The Coast Guard cutter *Maple* retrieved the last three buoys on November 19, and after unloading buoys and special

equipment at Rochester left for Ogdensburg, N.Y. The *C.A. Dambach* of the State University of New York finished inshore biological-chemical studies on December 8 and returned to Youngstown, Ohio. The Oswego T-boat, operated by the State University of New York, completed inshore biological-chemical studies on December 14 and returned to Oswego, N.Y.

Aircraft Operations

Aircraft operations were conducted during the fourth and fifth alert periods, October 1 to 14 and November 8 to 22, 1972. A coordination meeting was held on September 30 in the Niagara Air Force Base operations briefing room to arrange procedures for intercomparison of aircraft-to-aircraft and aircraft-to-surface flux-measuring equipment.

The following aircraft participated in the fourth alert period:

Aircraft	Principal Investigator	Operator
De Havilland Buffalo (N326D)	J.W. Telford	NCAR
DC-6 39C	B.R. Bean	RFF, NOAA
T-33 CFSKH	G.A. McBean	NAE, Canada
Queen Air N304D	M.A. Estoque	NCAR
Cessna 310 CFVLE	M. Donelan	CCIW, Canada
Aztec CFHRA	R.M. Holmes	AES, Canada
De Havilland Buffalo	A.E. Strong	NOS, NOAA
Twin Beach Bonanza	E. Peck	EG & G, Inc.
Aztec C	K.R. Piech	Cornell Aeronautical Laboratory
C-47	F.C. Polcyn	University of Michigan
Bell 204B	H.H. Kim	NASA

Flux measurements were taken during this period at the following surface sites:

Site	Investigator
Niagara Bar tower	M.A. Donelan
Lighthouse Road tower	J.A. Businger
Port Credit tower	F.C. Elder
Cobourg tower	J.A. Businger

The aircraft reporting and FAA Flight Service support worked exceedingly well during the fourth alert, traffic advisories being relayed to all project aircraft each day. With the number of aircraft involved, at times up to four aircraft were flying low passes near the surface at approximately the same time. Separation was maintained by the pilots through radio communication and by using opposite ends of the lake for flux-measuring missions.

Tours through project aircraft were arranged during this period for Drs. Takeda, Fiyitana, Matsuto, and Ninomia visiting from Japan, Dr. Kullenberg, University of Copenhagen, Denmark, and Dr. Westerberg, University of Gothenburg, Sweden.

During the fifth alert period, NOAA's RFF DC-6 39C and NCAR's De Havilland Buffalo participated in a final venture to measure flux values over Lake Ontario. Attempts were difficult because of weather and maintenance problems, but the DC-6 39C was able to complete four research missions and the De Havilland Buffalo three. Flights for intercomparison with surface sensors were not made due to the lack of the latter, and the one intercomparison flight between the two aircraft was cancelled because of maintenance required on the Buffalo.

Buoys, Towers, and Land Stations

All 20 observation platforms in the IFYGL Texas Instruments network of buoys, towers, and land stations were operational during October. The lake stations were removed on the following dates:

Station No.	Date	Station No.	Date
15	Oct. 12	18	Nov. 6
9	Nov. 1	5	Nov. 7
6	Nov. 1	13	Nov. 17
4	Nov. 2	8	Nov. 18
3	Nov. 2	10	Nov. 18
16	Nov. 5	11	Nov. 19
17	Nov. 5	12	Nov. 29

The air and water temperature, and barometric pressure sensors were postcalibrated in Rochester. Calibration checks were made on the current meters, dew cells, and wind velocity and direction sensors. A few wind velocity sensors were checked at the University of Michigan and then used for reference standards in the Rochester wind tunnel. The precipitation gages and evaporation pans were also checked. Checks on some of the radiometers were done by R.J. Latimer's group at AES, Downsview, Ontario.

Equipment from two of the towers was sent to the Lake Survey Center (LSC) and from the other two to the National Data Buoy Center (NDBC) in Bay St. Louis, Miss. All buoys were sent to NDBC. Both LSC and NDBC have plans for using the equipment in 1973.

Comparison of the lake stations with a similar system aboard the *Johnson* was completed, and the data were reduced on a minicomputer in Rochester. Some of the sensor calibration data were also processed. The output is archived at CEDDA.

With the removal of the lake stations, personnel was reduced from 10 to 4 for operation and maintenance of the remaining six stations through March 31, 1973.

Buoy, Tower, and Land Station Data

Significant progress in clearing up and filling the TI data set is being made under the direction of Jim Harrison, IFYGL Project Office, who is serving as lead analyst. A team of five people has been formed to expedite this data processing task at CEDDA and LSC.

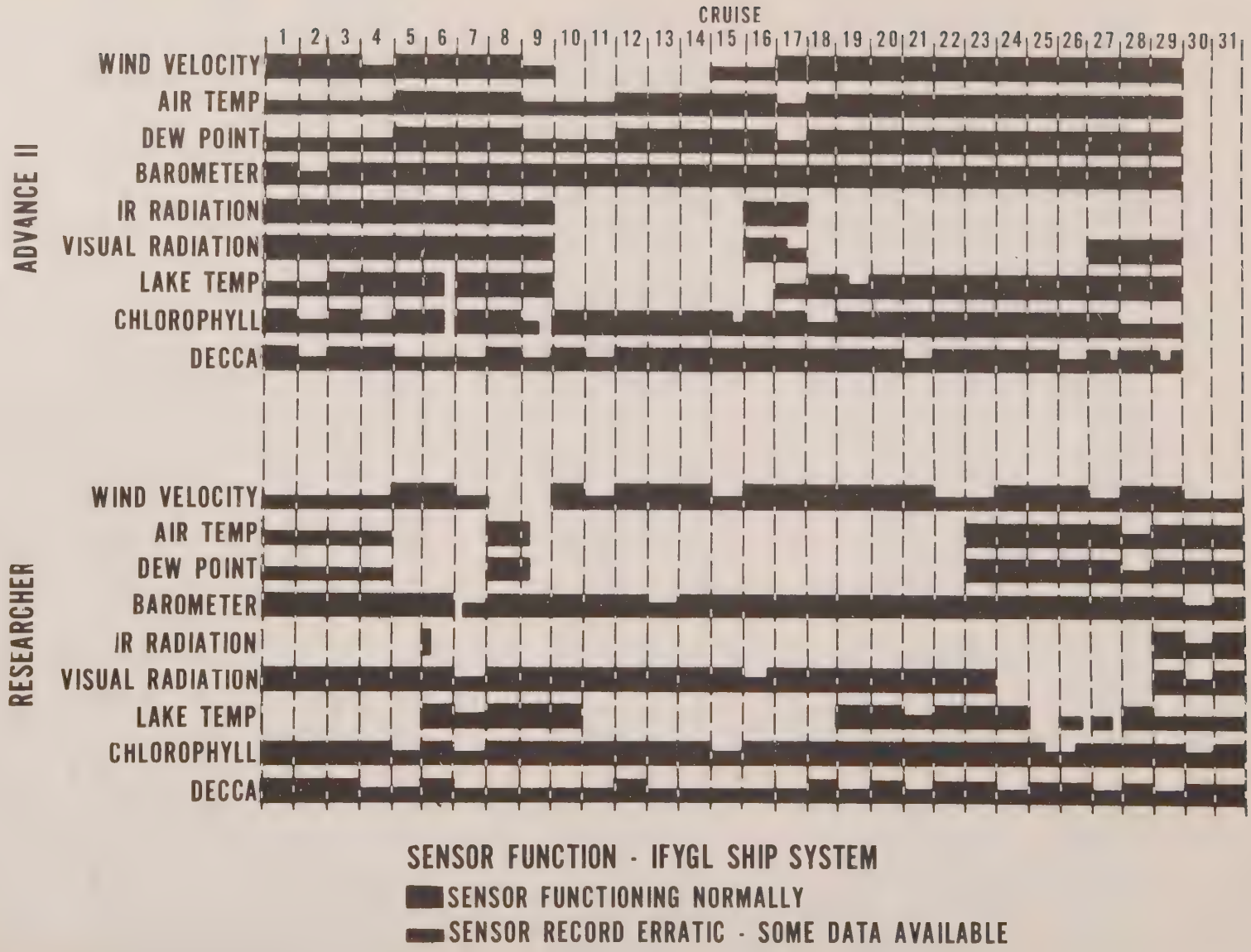
Target data for completing the provisional data base for all sensors for the first 2-week period -- July 7 to 21, 1972 -- is August 1973. Additional weeks of data for all stations can be processed initially at the rate of 1 calendar week for each week of data, with a target date of March 1974 for completion of the entire provisional data base. Final processing and editing is estimated to begin in January 1974, with an expected completion date of June 1974.

Ship Data

Processing of the data collected by the *Researcher* and the *Advance II* is progressing on a revised schedule, with a modified procedure to be completed shortly. By July 1973 the provisional data base is estimated to contain 20 ship cruises. Data from the additional 40 cruises will be processed between July 1973 and February 1974. Final processing and editing will be done between January 1974 and August 1974. The first 20 cruises to be processed are:

Researcher: cruises 3, 7, 9, 11, 16, 17, 21, 23, 27, and 31.
Advance II: cruises 2, 5, 7, 9, 14, 15, 19, 21, 25, and 29.

A gross evaluation of what can be expected in terms of data output from the ship systems has been made. This evaluation is graphically illustrated in figure 4, which shows the operational status of each of the sensors on both ships for each cruise. Operation of the electrobathythermograph (EBT) aboard the *Researcher* is not shown in the figure. The EBT was not functional during cruises 1 through 6, and was not used during cruises 15 and 23. The EBT temperature sensor was erratic on cruises 7, 8, 12, 13, 16, 17, 19, 20, 22, 24, and 26 through 31, but functioned well on other cruises. The dissolved oxygen sensor was nonoperational during cruises 11, 12, 17, 18, and 31, and was erratic during cruises 7, 8, 14, 22, 24, and 26 through 30. On the *Advance II* the EBT recorded only temperature vs. depth. Operation was erratic during cruises 1 through 7, 9, 14, and 22, and the EBT was not used on cruises 11 and 21. The 400-m head for deeper casts was inoperative during cruises 23 through 25.


CRUISE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
ADVANCE II
WIND VELOCITY
AIR TEMP
DEW POINT
BAROMETER
IR RADIATION
VISUAL RADIATION
LAKE TEMP
CHLOROPHYLL
DECCA
RESEARCHER
WIND VELOCITY
AIR TEMP
DEW POINT
BAROMETER
IR RADIATION
VISUAL RADIATION
LAKE TEMP
CHLOROPHYLL
DECCA
SENSOR FUNCTION - IFYGL SHIP SYSTEM
SENSOR FUNCTIONING NORMALLY
SENSOR RECORD ERRATIC - SOME DATA AVAILABLE

Rawinsonde Data

The necessary manual workup of 10 to 20 percent of the approximately 3,000 soundings will be done at Tinker Air Force Base. Microfilm copies of the original data going to Tinker (by courier) will be retained at CEDDA. A projected date of July 1973 for provisional data covering the period October 30 to November 5, 1972, remains firm.

The effect of making the radiosonde midreference correction was investigated. In a check of six soundings, the correction amounted to more than 0.6°C between soundings and up to 0.3°C within a single sounding. The conclusion was drawn that the correction should be kept.

IFYGL Joint Management Team

A draft of the U.S. IFYGL data products schedule was presented to the Joint Management Team on February 22. One of several new items outlined in the draft concerns the mechanics of data exchange, both national and international, with the EPA/STORET center.

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